Compressed Air Magazine

Vol. 43, No. 2 | London - New York -Paris | February, 1938

THE LEVIATHAN

ON THE COVER

OUR cover picture is a view along the starboard side of the upper part of the *Leviathan.* It was taken when the great ship was in transatlantic passenger service and gives evidence of the spick-and-span condition in which she was kept. The photograph is reproduced through the courtesy of the United States Lines.

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IN THIS ISSUE

THE "Big Train" has made her last trip. Thousands of Americans, particularly World War survivors that she carried to or from France, will mourn the unromantic end of the *Leviathan.* She was the only superliner that ever sailed under the Stars and Stripes. The high points in the kaleidoscopic career of this ill-starred floating palace are told by Robert G. Skerrett. Some of the facts given have not, to our knowledge, been previously printed.

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AT SOMERVILLE, N. J., falling water has been made to pump drinking water for more than 50 years. Such a plant is outstanding in economy of operation and highly reliable, but still subject to occasional failure. To guard against such an emergency, steam has been kept up for a half-century, although seldom used. Diesel engines have now supplanted steam equipment with resultant economies and without sacrificing dependability.

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IN GENERAL, the economy of Jackbits rises as the hardness of the rock being drilled increases. This is particularly true if conventional drill steel must be transported long distances for resharpening. A case in point is the Cliffs Shaft Mine on the Marquette Iron Range. Mr. C. J. Stakel, superintendent of the mine, sets forth the savings that Jackbits have effected there and describes in detail the methods of handling them.

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CORRECTIONS AND CREDIT

FRED DOPP, perennial hand-drilling champion, has called our attention to some errors in the article *Super Hammermen* in the January issue. The drillers pictured on page 5501 are George and Mickey Coughlin, present double-hand champions, and not Arch Walker and Edward Saunders. The team of boys shown on page 5500 drilled 14½ inches in seven minutes, or 10 inches more than we gave them credit for. Finally, it was Thurman Collins, not Peterson, who teamed with Dopp when 40 inches were drilled in Platte Canyon granite.

In the article by Robert G. Skerrett on *Reclaiming the Everglades*, credit for the accompanying illustrations should have been given to the U. S. Department of Agriculture and the Corps of Engineers, U. S. Army.

Compressed Air Magazine

Volume 43 — FEBRUARY, 1938 — Number 2

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EDITORIAL CONTENTS

ADVERTISING INDEX

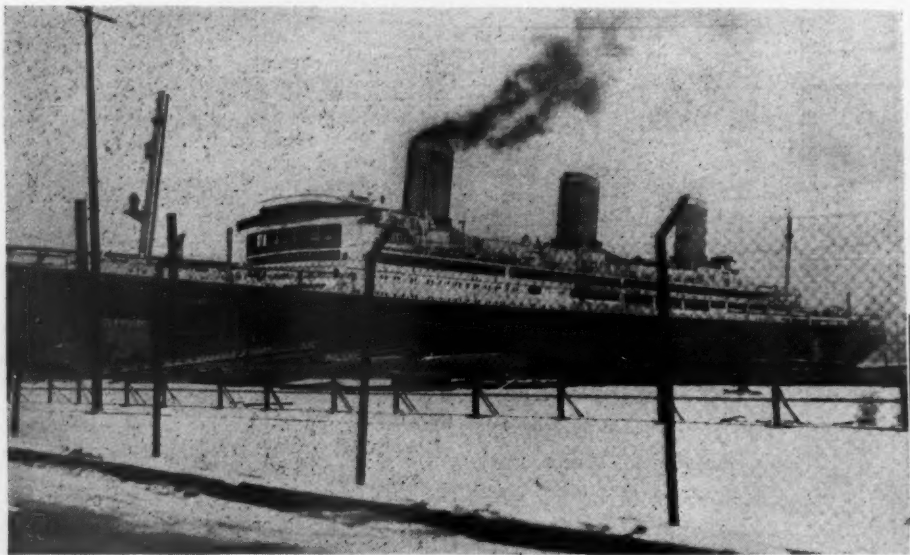
A monthly publication devoted to the many fields of endeavor in which compressed air serves useful purposes. Founded in 1896.

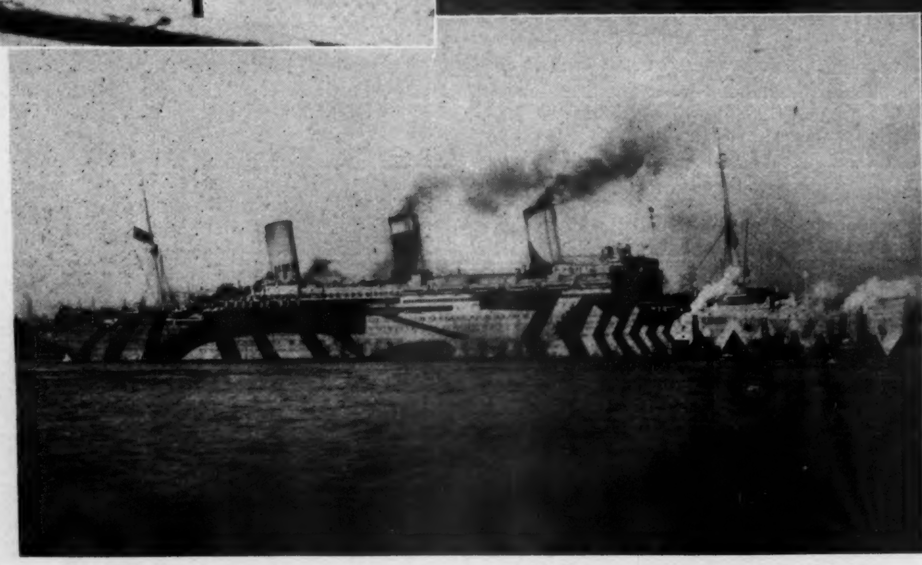
Published by Compressed Air Magazine Company. G. W. MORRISON, president; R. A. LUNDELL, vice-president; F. E. KUTZ, secretary-treasurer.
Business, editorial, and publication offices, Phillipsburg, N. J.
Advertising Office, 11 Broadway, New York, N. Y.
Annual subscription price: domestic, \$3.00; foreign, \$3.50. Single copies, 35 cents.
Compressed Air Magazine is on file in many libraries and is indexed in Industrial Arts Index.

TRANSPORT, FLAGSHIP, WHITE ELEPHANT

The passing years brought about more dramatic changes in the status of the *Leviathan* than were ever experienced by any other superliner. Built for speedy transatlantic service, she spent nearly one-third of her troubled existence tied up motionless at a Hoboken pier. As the *Vaterland*, she flew the flag of Germany on only seven voyages. Under the Stars and Stripes she was of great help as a carrier of troops, but afterwards, in commercial service, she proved to be an expensive luxury. During 1934 she lost $100,000 a trip on five trips for her erstwhile owners, the United States Lines, and was withdrawn from the seas. For keeping her inactive in 1935 and 1936, in violation of their contract with the Government, they had to pay a fine of $500,000. In addition, it cost $150,000 a year to maintain her in idleness. In the end she steamed down New York Harbor on January 25 under the British Union Jack, bound for the boneyard at Rosyth, Scotland. The bottom view shows the *Leviathan* in her wartime jay-bird camouflage of black, white, blue, and gray. At the right she is seen, reconditioned, as flagship of the United States Lines. Below she is pictured at Pier 4, Hoboken, with steam up for her final voyage. Note that her stacks and masts have been shortened to enable her to pass under the Firth of Forth Bridge.

Photos from United States Lines and Navy Recruiting Bureau





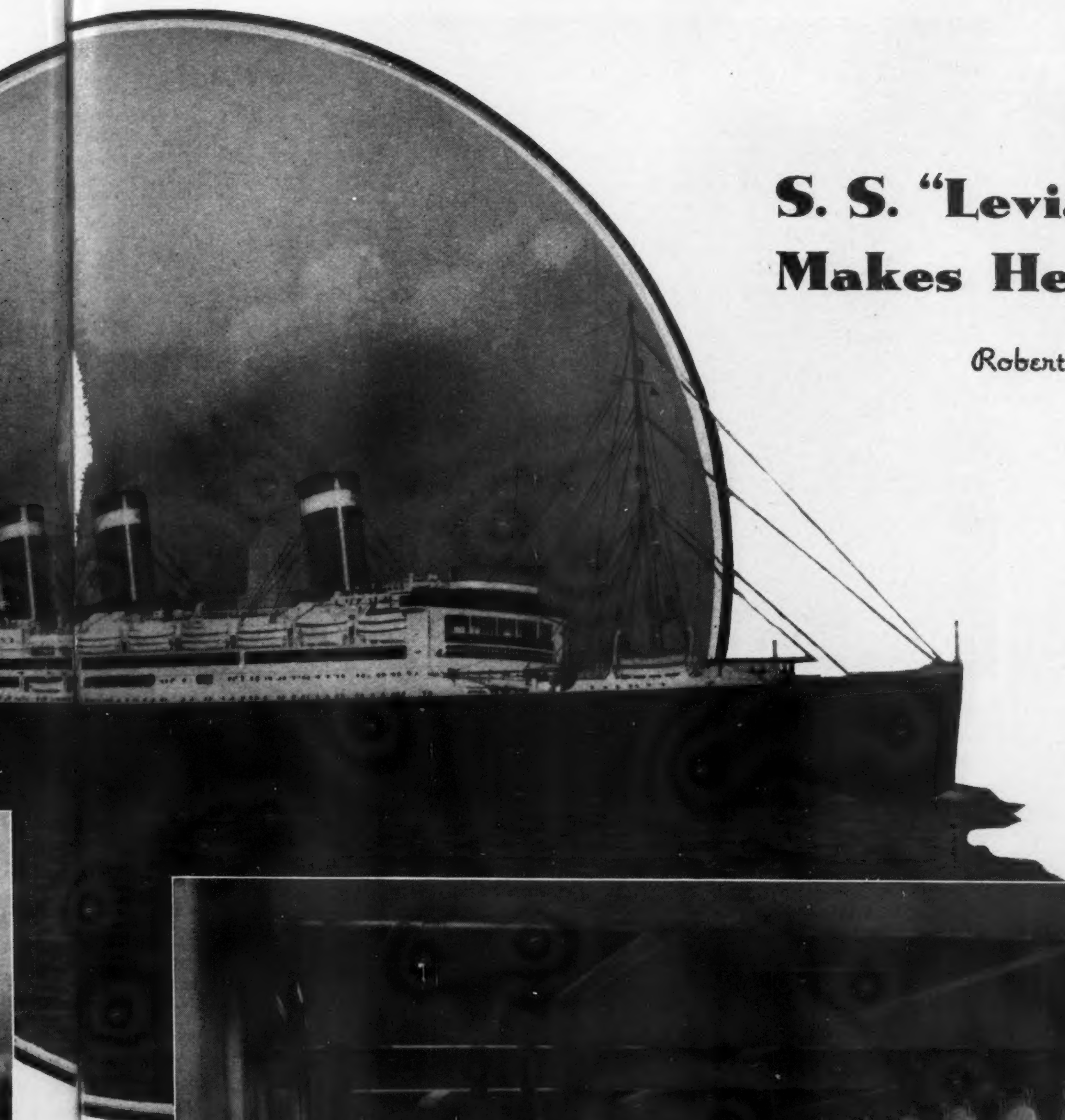
LIKE a time-marked *grande dame* retiring from the scene of her erstwhile triumphs, the great steamship *Leviathan* recently backed away from her pier at Hoboken under her own power and, on reaching midstream of the Hudson River, swung her head oceanward for the final voyage of her career.

With her topmasts lowered, her smokestacks shortened to give her clearance under the famous Firth of Forth Bridge, and otherwise outwardly dowdy because of her badly weathered paintwork and the absence of some of her accustomed equipment, yet the manner in which she maneuvered, and the deep-booming blasts of her big whistle as she returned the vociferous salutes of harbor craft, attested the mechanical sufficiency and reserve forces of the big ship. Clamorous as her departure was, there was nevertheless a somber side to her going, because, while yet structurally sound and prime in every essential particular, she was leaving our shores to be scrapped by shipbreakers abroad!

As the Hamburg-American liner *Vaterland*, the vessel was launched in April of 1913 at the Hamburg shipyard of the well-known firm of Blohm & Voss. A trifle more than a year later she left her home port on her maiden run and reached New York on May 21, 1914, having covered the distance in seven days. Her arrival in the harbor was noisily acclaimed by every craft equipped with a whistle, and large crowds along both waterfronts added their hurrahs of welcome. At that time the *Vaterland* was the biggest and finest passenger ship in service; and she gave every reasonable promise of many years of efficient and profitable employment. Her builders and owners had the best of reasons for pride in her.

The liner had made but three round trips and had reached New York after her seventh crossing of the Atlantic when war was declared between France and Germany on August 1, 1914; and for her security she was promptly interned at her dock in Hoboken, N. J. That enforced lay-up was the first of several that were to curtail the active service of the ship in the course of her nearly 25 years of existence. She was seized by the United States authorities when we entered the World War early in April of 1917; and during the more than 20 years the vessel carried the American flag she was idle about half the time. Even so, what the great craft did as a troopship during the World War should make her forever memorable.

The *Vaterland* was turned over to the U. S. Navy shortly after her seizure, and towards the end of July, 1917, was regularly commissioned and assigned to transport duty. She was officially named *Leviathan* in September of that year. Immediately following her transfer, steps were taken to overhaul her, to repair any damages due either to wear or to sabotage on the part of



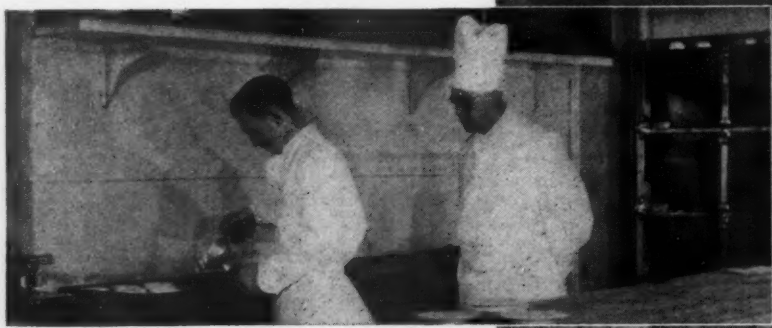
S. S. "Leviathan" Makes Her Last Run

Robert G. Skerrett

Courtesy, Newport News
Shipbuilding & Dry Dock Co.

NAVIGATION BRIDGE
From this station, the height of which above the water is equivalent to the eighth floor of an office building, the *Leviathan* was controlled. These instruments and their extensive connections provided instant contact with all parts of the intricate mechanical facilities below decks.

United States Lines Photos



DINING SALON AND GALLEY

At the right is shown an outside wing of the beautifully appointed dining salon. Above appears a small section of the main kitchen where waffles and pancakes were made to satisfy the sharpened appetites of the breakfasters. When sailing with a full passenger list, the big ship's larder normally carried 17,000 pounds of beef, 5,000 dozen eggs, and 6,000 pounds of butter.

her erstwhile German personnel, and to recondition her for the carriage of troops. To this end it was necessary to examine with the utmost care every part of the hull and machinery, to discover any hidden defects, and then to make the ship structurally and mechanically fit for the exacting and vital service ahead of her. All passenger accommodations below D deck were torn out, and the spaces thus made available were transformed into accommodations for thousands of soldiers, sailors, and marines to be moved on each eastward transatlantic run.

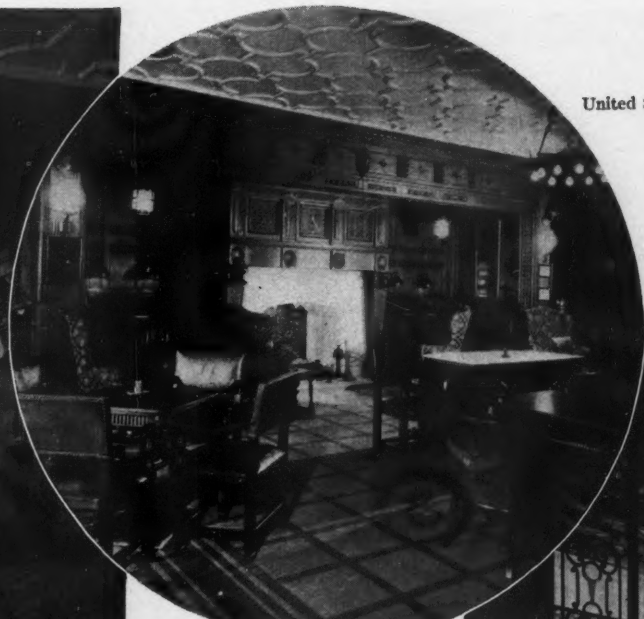
So well and speedily was the work of reconditioning and outfitting done that the *Leviathan* was reported ready for sea on November 16, 1917; and the very next day she slipped out of the Port of New York on a trial run to West Indian waters. On that trip the ship behaved splendidly and showed that she was qualified for the important task assigned her. Upon her return to New York she was loaded with stores, fuel, and other cargo sufficient to meet her needs on a run to Europe and back. Then came the embarkation of troops for the reinforcement of the Allies—the vessel's operating personnel increasing the 7,254 men on board at that time by more than 2,000.

In the dim light of dawn, on December 15, the *Leviathan* left New York on the first of her ten eastward trips to France prior to the end of hostilities; and during those runs she transported 94,183 fighting men for service in Europe. On her seventh trip eastward she had aboard 11,470 soldiers in addition to her personnel of 2,078—the greatest number carried up to that time by any ship on a single voyage. Between December 15, 1917, and September 8, 1919, the *Leviathan* made nineteen runs all told, her westward trips being principally devoted to bringing back quickly and in comfort thousands and thousands of our wounded and suffering men. On those runs she brought home 93,746 of our fighting forces; and throughout her period of service as a transport she moved, besides her operating complement, a total of 187,929 persons.

In carrying troops to and fro, provision had to be made for the prompt and ample feeding of all on board; and so well did the Supply Corps of the Navy deal with the problem of subsistence that it was practicable repeatedly to give 9,000 men their food in the astonishingly short time of 67 minutes! That was quite in keeping with the transit performances of the *Leviathan*, for in the summer of 1918, when the need of soldiers was most pressing, the ship made a complete round trip in the remarkably brief span of 16 days and 23 minutes. It was because of what she did as a naval transport that her passengers variously and even affectionately dubbed the great craft *The Big Train*, the *Levi*, and the *Levi Nathan*, according to the mood or humor of the speaker. She was, indeed, a gigantic "ocean ferry"; and no other vessel then available could have served in that capacity so well.

Looking backward, it is a cause of wonderment that the vessel escaped damage and even destruction in traversing the watery areas known to be infested with enemy submarines. Strangely, not more than two hostile periscopes appeared during the ten voyages prior to the armistice. The first of these popped up in the Irish Sea when the *Leviathan* was on her initial run and surrounded by a group of escorting destroyers. The latter promptly dropped a succession of depth bombs; and whether or not they hit and disabled the enemy U-boat, that craft was not seen thereafter. On her fifth trip eastward, when about to enter the Port of Brest in May of 1918, an enemy submarine made the fatal mistake of showing her periscope at a point off the *Leviathan's* quarter. Her rapid-fire guns handled that situation promptly and effectually—the periscope disappeared and the U-boat either foundered or sought escape under cover of the protecting water. So far as records show, the *Leviathan* made her other wartime voyages without visible evidence of enemy threat. Nevertheless, the fact that she escaped unscathed is something of a marvel because of her great size and the large target she offered to pot-hunting submarines bent upon sinking or damaging any kind of craft serving directly or indirectly the cause of the allied nations.

With the war over and the *Leviathan* no longer needed for transport service, she was put out of commission as a naval vessel and turned over to the U. S. Shipping Board, which suddenly became the vexed possessor of an immense fleet for which no peacetime use then existed. The *Leviathan* was laid up to await the evolving of an operating program on the part of that Board. It took that Government organization some time to arrive at a decision—the *Leviathan* looming large as a nautical "white elephant" demanding either sale, scrapping, or reconditioning at the taxpayers' expense. Her war service had been the cause of considerable deterioration, and it was necessary to remove all the fittings with which she had been equipped for the work of transport before her rehabilitation as a passenger liner could be undertaken. This virtually meant overhauling the craft from masthead to keel, as well as every part of her internal structure and all mechanical features. Furthermore, it involved refitting her so that she should be the equal, if not



United States Lines Photos

FLOATING SPLENDOR

As the *Vaterland*, the great ship was beautifully appointed. When rehabilitated by the United States, following her transport service, she was even more lavishly decorated and furnished. This group of interiors gives an idea of her luxuriousness.

the superior, of competitive ships of her type.

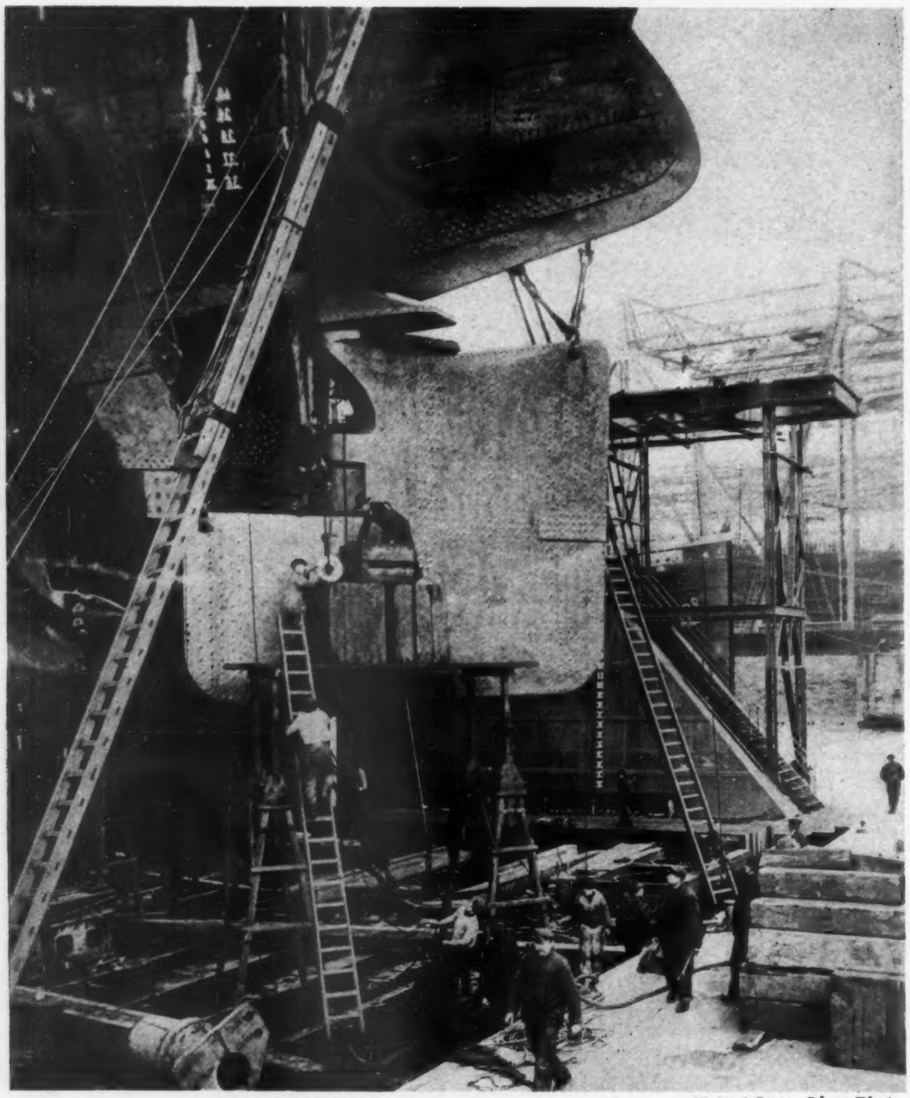
The U. S. Shipping Board adopted an ambitious program of rehabilitation and improvement of the *Leviathan* towards the end of 1919; but before work on that enormous task could be begun, it was necessary to have an intimate knowledge of every structural feature of the ship. This could be obtained by studying the detailed plans of the vessel. Those plans, however, were in the possession of the former German owners of the liner. When approached by our people, the shrewd Teutons, thinking that they had us where they could demand their own price, asked $1,000,000 for them. After years of lavish spending, the Shipping Board had become sufficiently canny not to respond to a hold-up and, instead, determined to essay the rare and well-nigh staggering job of producing new and complete drawings and specifications of the ship. Only the initiated can appreciate what that meant; but let us sketch in general terms what was entailed.

The *Leviathan* has an over-all length above water of 950 feet 7 inches; she has a water-line length of 926 feet 6 inches; her maximum beam or breadth is 100 feet; and from the underside of her keel to her navigation bridge she has a height of 124 feet. At normal lading she draws about 40 feet of water. Her total dead weight or displacement—not her registered tonnage—is around 62,000 tons. The ship was originally equipped with 46 water-tube boilers using coal for fuel. To drive her, she carried eight main turbines—four of them for backing service, and all eight were arranged on four shafts each carrying a single great propeller.

The vessel's hull is divided vertically by nine steel decks running fore and aft at different levels; and the interdeck spaces, depending upon their locations, are subdivided primarily into a succession of watertight compartments and then cut up into innumerable smaller subdivisions to meet all kinds of structural and operating requirements—including, of course, accommodations for various classes of passengers and for officers and crew. In addition to the main power plant, the liner was equipped with scores and scores of mechanical auxiliaries in the form of pumps, blowers, electric generators, etc., etc. Leading from the different auxiliaries, according to their respective functions, were run miles and miles of piping for the distribution of steam, water, and refrigerating brine, for the circulation of fresh air, and for the disposal of wastes of different sorts. Correspondingly, like a titanic nervous system, a veritable maze of electric cables and lesser wires lead to every part of the ship to perform essential services. The pipes, the cables, and the wires had to trace devious and often long paths—crossing compartment after compartment and piercing many bulkheads and decks.

The *Vaterland* was designed to carry a maximum of 3,399 passengers of four classes and an operating complement of 1,100 officers and crew—a total of 4,499 persons for whose comfort, well-being, and entertainment many different conveniences and facilities had to be installed. Some of these provisions were elaborate and others were comparatively simple, yet all represented many thousands of fixtures or appointments. The reconditioning of the craft after her use as a transport meant the checking up and the measuring of every structural part and all her essential equipment. Then, with that fund of information available, the Board had to decide what should remain as originally provided and what changes should be made to bring the *Leviathan* up to date and to give her characteristics that she did not have when, as the *Vaterland*, she won the admiration of the maritime world.

The complicated and seemingly interminable task of preparing anew complete plans and specifications was given to William F. Gibbs while that expert was still chief constructor of the International Mercantile Marine Company. Mr. Gibbs promptly assembled an organization of about 150 men possessing intimate knowledge of ships and marine engines, and their first job was to measure every part of the *Leviathan*, inside and out, no matter how difficult of access it might be. Weeks and weeks of dogged and intensive inspection and work yielded the necessary data. Then the force was set to preparing detailed plans and exhaustive specifications so that shipbuilders could make accurate computations and intelligently submit lump-sum bids for the unified job of re-



United States Lines Photo

IN DRY DOCK

A picture taken while the huge liner was laid up for the overhauling of her rudder, propellers, and all other external underwater parts and surfaces.

conditioning, refurnishing, and refurbishing the great craft throughout.

Mr. Gibbs and his men did their work well and successfully, and they accomplished it notwithstanding frequent foreign assertions that the efforts would result in failure because we had never built a merchant liner comparable to the *Vaterland* in size or characteristics. Those critics were equally positive that no shipyard on this side of the Atlantic could handle the reconditioning job involved. Nevertheless, when the Shipping Board asked for bids after the plans and specifications were available, no fewer than seven responsible shipyards in this country made tenders for the job and backed up their offers with the prescribed certified checks to bind the bargain.

On February 15, 1922, the Board awarded the contract to the Newport News Shipbuilding & Dry Dock Company for the sum of $6,110,000. The work included converting the *Leviathan* from a coal burner into an oil burner capable of developing 100,000 hp., and changing the coal bunkers into thoroughly tight fuel-oil tanks. What was done at Newport News is something of which the entire nation may well be proud; and the magnitude of the task must be left to the imagination—it cannot be described fittingly. Aside from all structural and mechanical repairs, every bit of machinery was examined searchingly and restored to prime condition. Not only were the big main turbines opened up and any wear and tear corrected, but every condenser was retubed and all pumps and other auxiliaries placed in first-class working order. All steam and exhaust piping and kindred radiating surfaces were carefully relagged so as to insure greater heat conservation, greater economy of operation, than had been possible formerly. Every bit of the plumbing system—an extensive and intricate one—was gone over from end to end; and the steam-heating plant, with its virtually 2,000 separate radiators, was brought to a stage of efficiency that it had never reached before. A much improved and more extensive ventilating system was provided; fire protection of a wider and more advanced order was installed; and increased aids to navigation, internal communication, and the control of watertight doors were put in the ship to make her easier and safer to handle under all conditions. Reconditioning also included the repair of all acceptable furniture and the manufacture of other appointments in keeping with the new scheme of interior decoration.

Every item of work called for under the contract was completed within the limited term of fourteen months! After a shakedown run from Newport News to Boston, the *Leviathan* entered the great dry dock at the latter port on May 18, 1923, to be thoroughly cleaned and overhauled below the water line and to receive certain fittings and furnishings that would put her in final shape for transatlantic passenger service. Her rehabilitation cost us a total of $8,200,000.

Before arranging the *Leviathan's* sailing dates, the ship made a trial trip from Boston to the Bahamas and thence to the Port of New York, a distance of 2,185 knots, during which her oil-burning boilers furnished continuously enough high-pressure steam to give an average speed of fully 24 miles an hour for a sustained 25-hour run —an improvement upon her performance while a coal burner. She reached New York on June 24, 1923, and on July 4, following, left on her first eastward run as an American passenger liner. That was made possible because of the skill, the tireless labors, and the spirited coöperation of wellnigh everyone concerned in reconditioning the great craft for merchant service. It is this background of the *Leviathan's* intimate identification with us that makes it harder for us to see her go from our shores for immediate scrapping. On the other hand, her departure but serves to emphasize how rapidly styles in ships for swift passenger service upon the high seas undergo a change. This is brought about both by the demands of the traveling public and the economics of profitable operation. Even apart from mechanical efficiency, vessels in the highly competitive transatlantic trade can make money only if they prove popular for reasons other than what they represent as finished products of the naval architect and the marine engineer.

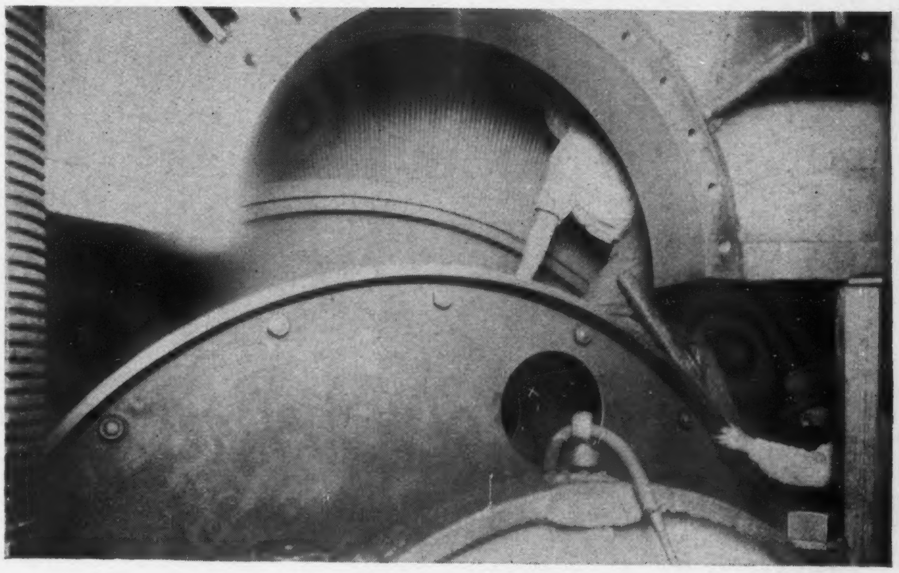
Carrying the British red ensign at her mainmast gaff, and with a complement of officers and men totaling fewer than 200, the *Leviathan* headed out of the Port of New York under her own steam on January 25, destined to the shipbreaking yard of Metal Industries, Ltd., at Rosyth, Scotland. That firm and Thomas W. Ward, Ltd., of Sheffield, England, are acting in collaboration in the purchase and dismantling and scrapping of the ship for ultimate disposal. They paid for the vessel, as she was at Hoboken, the sum of $732,000. They will make most of their money through the sale of the metal in her hull and of the permanent structural and mechanical features; but there will also be a handsome

return on the venture from apparatus of many kinds, furnishings, fittings, etc., that will probably find a ready market. Thomas W. Ward, Ltd., specializes in second-hand machinery and other equipment that can be utilized either afloat or ashore.

There is nothing about the preliminary stripping of a great passenger liner that differs essentially from kindred work in a large hotel still containing many of its appointments. With the so-called movables disposed of, then follows the careful taking down of decorative woodwork, architectural metalwork, and the salvaging of any ornamental fittings or features susceptible of re-use and sale. With the ship thus reduced to skin and bones, so to speak, Metal Industries, Ltd., will take on the concluding task of dismembering the craft piecemeal and of cutting up much of it into units of convenient size for remelting and conversion into ingots that will eventually take any form that the rebirth of usefulness may demand. Much of the dismembering will probably be done with the *Leviathan* tied up at a wharf and afloat; but after her hull has been progressively cut down until it rises only a few feet above the water, then what remains of it will be moved into a dry dock where complete demolition can be effected. The better part of a year will be occupied in achieving the scrapping of the liner.

Hundreds of thousands of rivets and a lesser but nevertheless great number of bolts were used in binding together not only the steel plates, angles, beams, and what not that form the hull structure but also the parts of most of the contributive structural members such as masts, smokestacks, ventilators, air ducts, boat davits, etc., etc. All these rivets must be cut off, the nuts on bolts removed, and other bonds severed so that the ship can be virtually dissected. In this fundamental work pneumatic tools such as socket and impact wrenches and pneumatic hammers of various sizes will have much to do. Plates and structural parts, however, that are intended for scrap for remelting will generally be cut up or out with the aid of the burning torch—the oxy-acetylene flame, while the final cutting up on shore of certain of the materials may be done with power-driven shears.

The use of the oxy-acetylene torch within a ship, where it is often the handiest cutting agency, invites difficulties, especially where the abandoned compartments are not any too well ventilated. The principal trouble arises from poisonous gases given off when the torch attacks the very paint that has served to give protection and finish to the underlying steel. During the life of a ship the accumulated coats of paint may attain a thickness of as much as a quarter of an inch. That pigment may contain a large percentage of lead, and the fumes of burning lead are noxious. Operators engaged in shipbreaking can be safeguarded from lead poisoning by first clearing away the paint along a desired line by means of a pneumatic chipping hammer. Then, with the steel bared, the torch can be used to cut the metal through with little if any risk of generating harmful gases.



A LOOK INSIDE

During the transformation of the ship from war to peacetime service she was given a most searching examination. Here is shown one of the main forward-drive turbines with the casing lifted to permit inspection of every one of the myriads of blades preparatory to making adjustments or replacements. The photograph is reproduced through the courtesy of the Newport News Shipbuilding & Dry Dock Company.

The scrapping of a craft of the size of the *Leviathan* is not a haphazard procedure. The program followed demands engineering knowledge and mechanical resourcefulness on the part of the men immediately in charge, because demolition must proceed in a manner that will not invite structural collapse nor in any way menace the men that are busily at work within the labyrinthine structure. Usually, where cargo hatches are not available to serve as ready passages, great openings are cut through the successive decks, from top to bottom, so that big pieces of machinery and skips loaded with tons of auxiliaries or parts may be lifted out of the depths and swung shoreward.

It is hardly necessary to tell the readers of this publication that the ferrous and nonferrous metals are carefully assorted and segregated so that the purchaser of scrap will get the particular metal that he desires. Of the different materials worked into the body of such a vessel the nonferrous scrap will bring the highest price per pound, and among the steel scrap, the metal that contains desirable alloys will be the most valuable. It is said that the hull of the *Leviathan* was constructed to a large extent of nickel-alloy steel. Steel of that sort is worked into naval and other guns and has further military applications. Both the British and the Japanese have latterly been the biggest buyers of scrap metal; and yet the Japanese failed to force up the bidding on the *Leviathan*. Possibly the Scotch buyers have a more intimate knowledge of what went into the ship when the Germans built her.

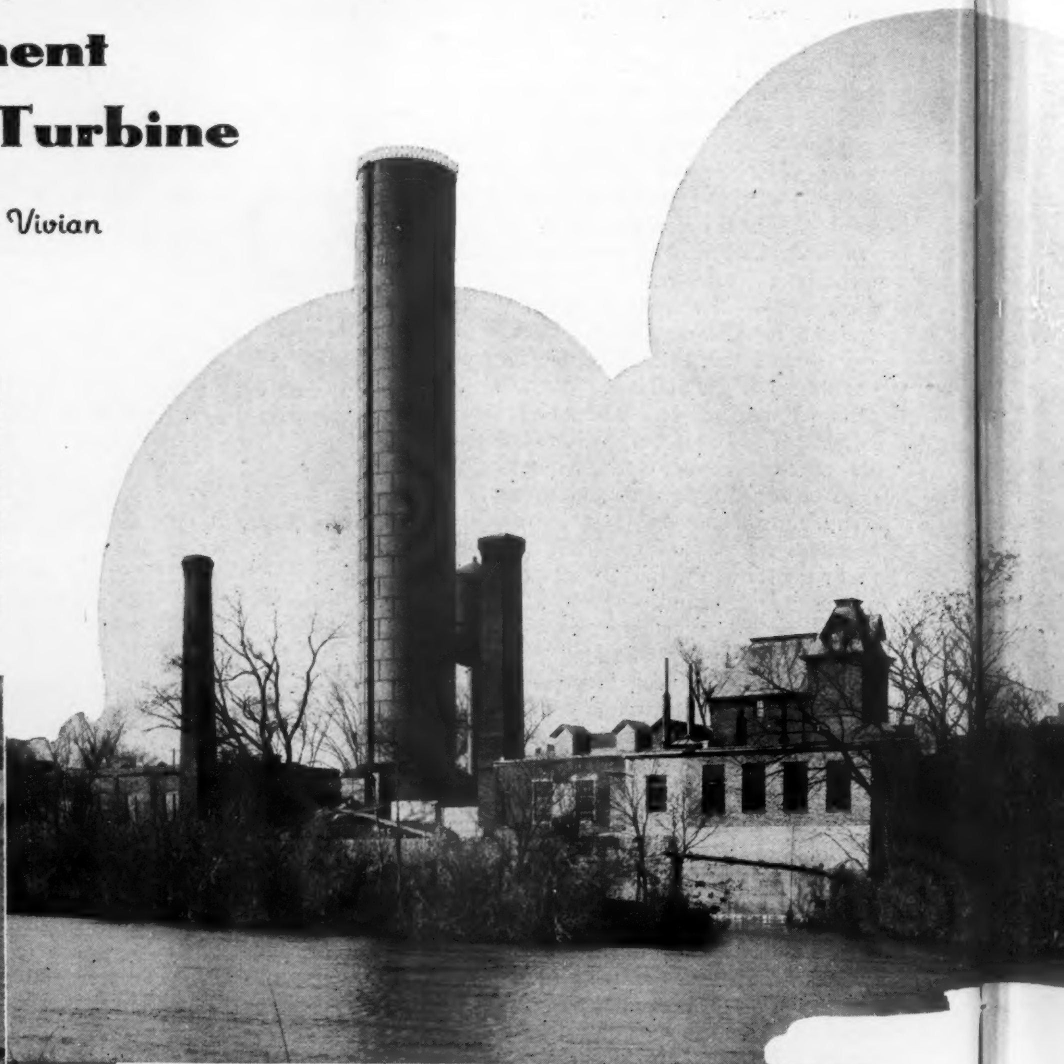
Present international conditions have placed a premium on scrap metal. Therefore its price is mounting, and shipbreakers are seeking far and wide for old vessels. Ordinarily, the British scrap annually some 400,000 tons of shipping, but recently the domestic demand has exceeded the sources of supply within the British Isles. The fundamental economics of the scrap-metal business is that a ton of metal can thus be obtained at less cost than by mining the ore, running it through the blast furnace, and later turning it into acceptable steel by another processing. The utilization of scrap metal may also lead to a substantial saving in transportation charges by eliminating the need of moving the ore from the mine to the blast furnace and its rehandling and carriage between the blast furnace and the steel mill.

While the scrapping of the *Leviathan* carries with it the implication of decadence, there still remains comfort in the thought that the old craft may furnish the substance for a better ship or contribute to many other worth-while products. Scrap metal is no longer junk: it officially bears the dignified classification of "secondary metals" and is, at times, primary in importance.

Considering the checkered career of the *Leviathan*, it was only natural that she should put on a final display of showmanship when near her last resting place. On February 4, while she was anchored a mile east of the Firth of Forth Bridge, a gale forced her downstream, with anchors dragging, and she narrowly escaped being grounded. As a sequel to her last journey, it was announced on February 9 that an auction of her contents and equipment will begin at Rosyth, Scotland, on March 14. After being stripped, she will be broken up.

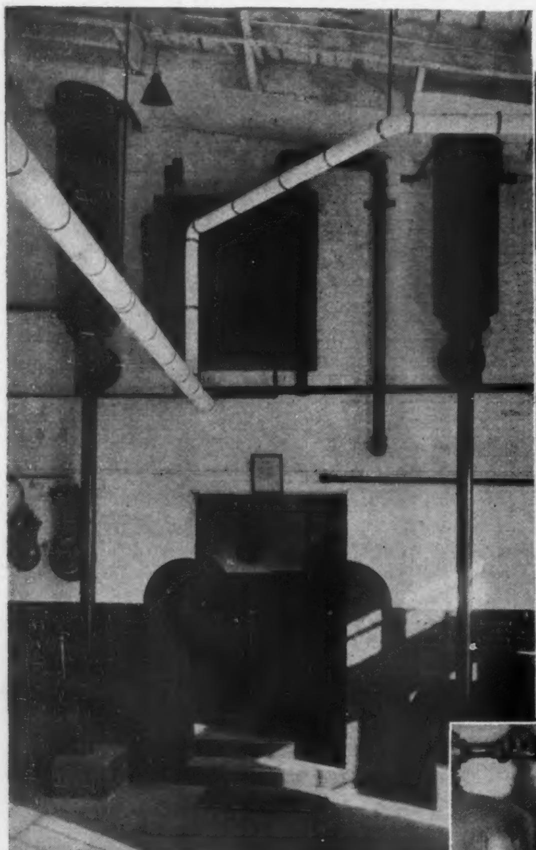
Diesels Supplement Water Turbine

C. H. Vivian



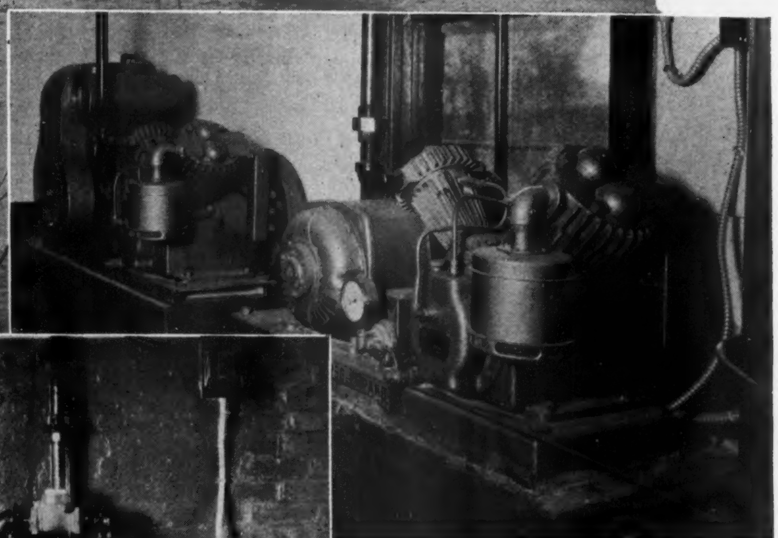
SOMERVILLE WATER PLANT

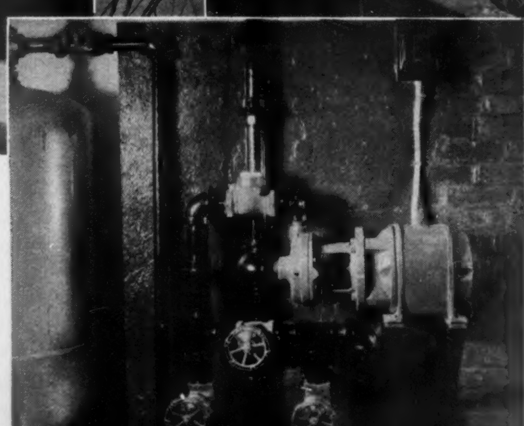
The pumps are in the building in the right foreground and the filters are in the taller structure just behind it. Water is lifted into the standpipe and flows from there by gravity through pressure filters and thence into the distribution mains. At the left of the standpipe is the Duke Farms pumping plant. Both plants normally employ water power to operate their pumps. This water is taken out of the Raritan River about 3 miles upstream and flows to the plants in an open canal. The tailrace of the Duke plant is hidden by the rise in the foreground. It joins the Somerville plant tailrace, which may be seen flowing into the river.



CRAMPED QUARTERS

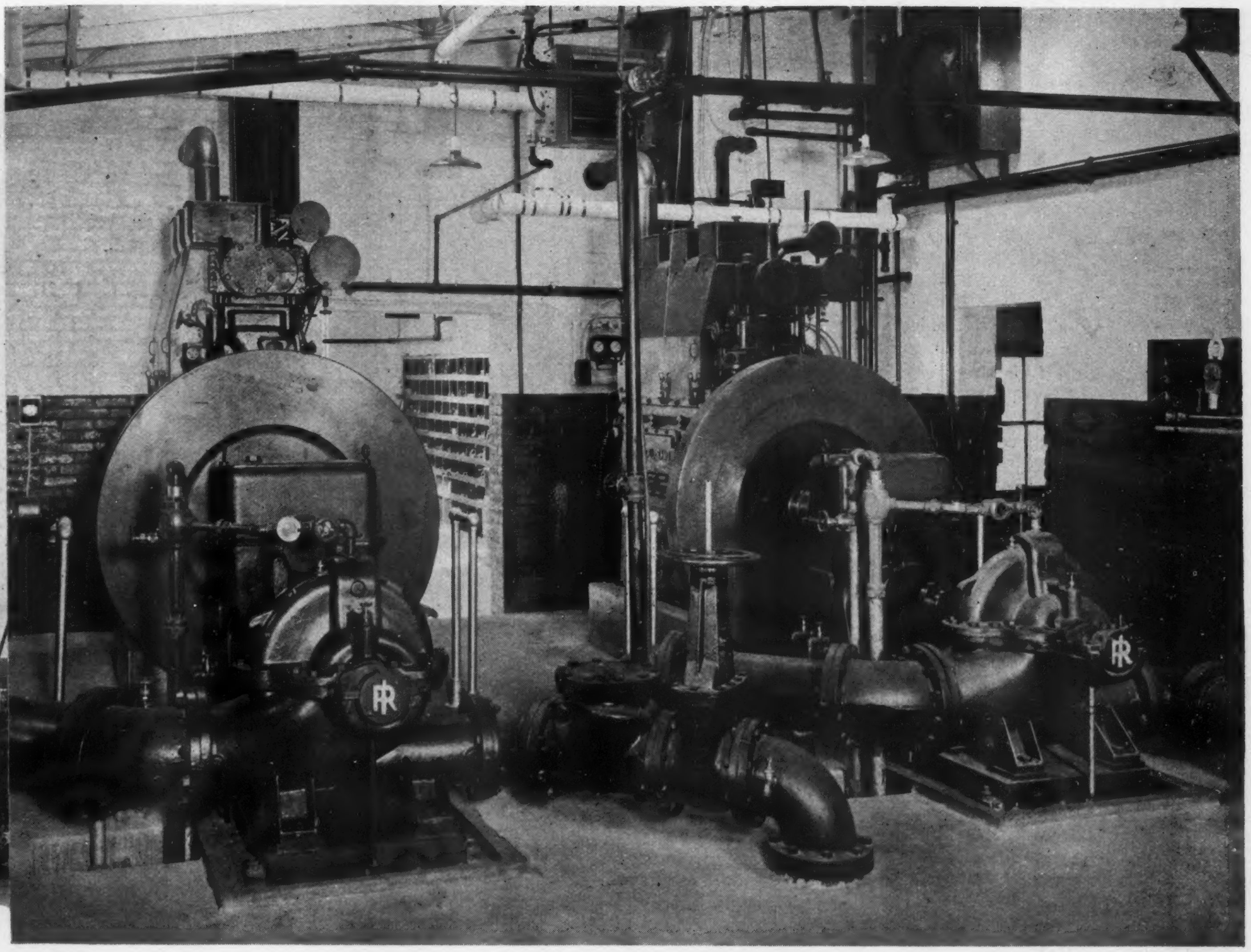
The diesel engine sets are in the room beyond the wall (above), but because of insufficient space the exhaust pipes were run through the wall and thence to the roof. The square tank is for circulating water for one of the engines, and it, too, had to be placed outside the engine room. One of the factors that led to the selection of the Type S engines was their compactness. Had some of the other engines also under consideration been chosen, it would have been necessary to tear out a portion of the wall shown here and to construct a steel-supported archway between the two rooms.





DIESEL-ENGINE AUXILIARIES

The diesel engines are started with air at 250 pounds pressure, which is supplied by either of two compressors. One unit is driven by a gasoline engine and the other by an electric motor. Cooling water is circulated by two 1½-hp. Motorpumps, there being one unit for each engine. As shown at the left, the pumps require no foundations and are mounted on wall brackets. At the left of the pump is a part of one of the two welded, steel, high-pressure air receivers.



DIESEL-DRIVEN PUMPS

These two units occupy the space formerly taken up by the two steam-driven pumps. The diesel sets, as they stand, are complete pumping plants, whereas the pumps they replaced required a boiler plant and a coal bin that occupied two other rooms. Under those conditions it was necessary to keep up steam at all times, although it was seldom used. The diesels, on the other hand, consume no fuel except when they are actually operating. Each of the engines is a 3-cylinder, 150-hp. unit and drives a Cameron pump of 3,450,000 gallons daily capacity through a speed-increasing gear. At the extreme upper right is a portion of one of the two day tanks for engine fuel, the main storage tank being located underground outside of the building. The square tank against the wall above the right-hand diesel is for the storage of circulating water for one of the units. The room beyond, formerly a boiler room, is now fitted up as an office.

WITH the installation of two diesel engines to operate with a water-driven turbine in maintaining a pumping service, patrons of the Somerville Water Company of Somerville, N. J., are receiving their water from a plant that combines the oldest and the newest types of prime movers in existence. Water wheels served the Pharaohs of ancient Egypt, while the diesel engine has been known for less than half a century.

The force of falling water has been transformed into mechanical energy for pumping Somerville's water ever since the local company began operations in 1881. Prior to that time the community was supplied with water by two different systems. A spring at the base of a mountain about a mile north of the village was the first source of supply. From it water was run through a pipe line made of hollowed-out logs. One end of each log was tapered and driven into the belled end of the next one, thus forming a continuous line. At certain places, taps were carried to the surface and the water run through troughs and into cisterns. Many pieces of this crude pipe line have been dug up during the making of street repairs. The logs were from 8 to 10 inches in outside diameter and the bore was about 4 inches. Later on, most of the houses had private wells, and the only source of community supply was a hand-operated pump.

In 1876 there was a drought of such severity that many wells went dry. Patrols were established at night to keep watch for fires. This drought led to talk about a public water system, but no steps were taken towards constructing one. In 1880 an even worse drought was experienced, and in the fall of that year the Somerville Water Company was organized and a plant built at its present location. It went into service on March 1, 1881.

Throughout the intervening years, water power has been relied upon for pumping; and, realizing that it might on occasions fail, it has been the part of prudent management to provide some alternate means of pumping to safeguard the community against a stoppage of one of its vital utilities. Until a few months ago, steam engines were held in reserve. That necessitated maintaining and operating a boiler plant at all times. Only a small percentage of the steam developed was ever used; but, even so, it had to be held in readiness for emergency service 24 hours a day. This was obviously an uneconomic arrangement. Consequently, when the existing steam plant gave definite indications last year of impaired dependability, it was decided to substitute diesel power for steam.

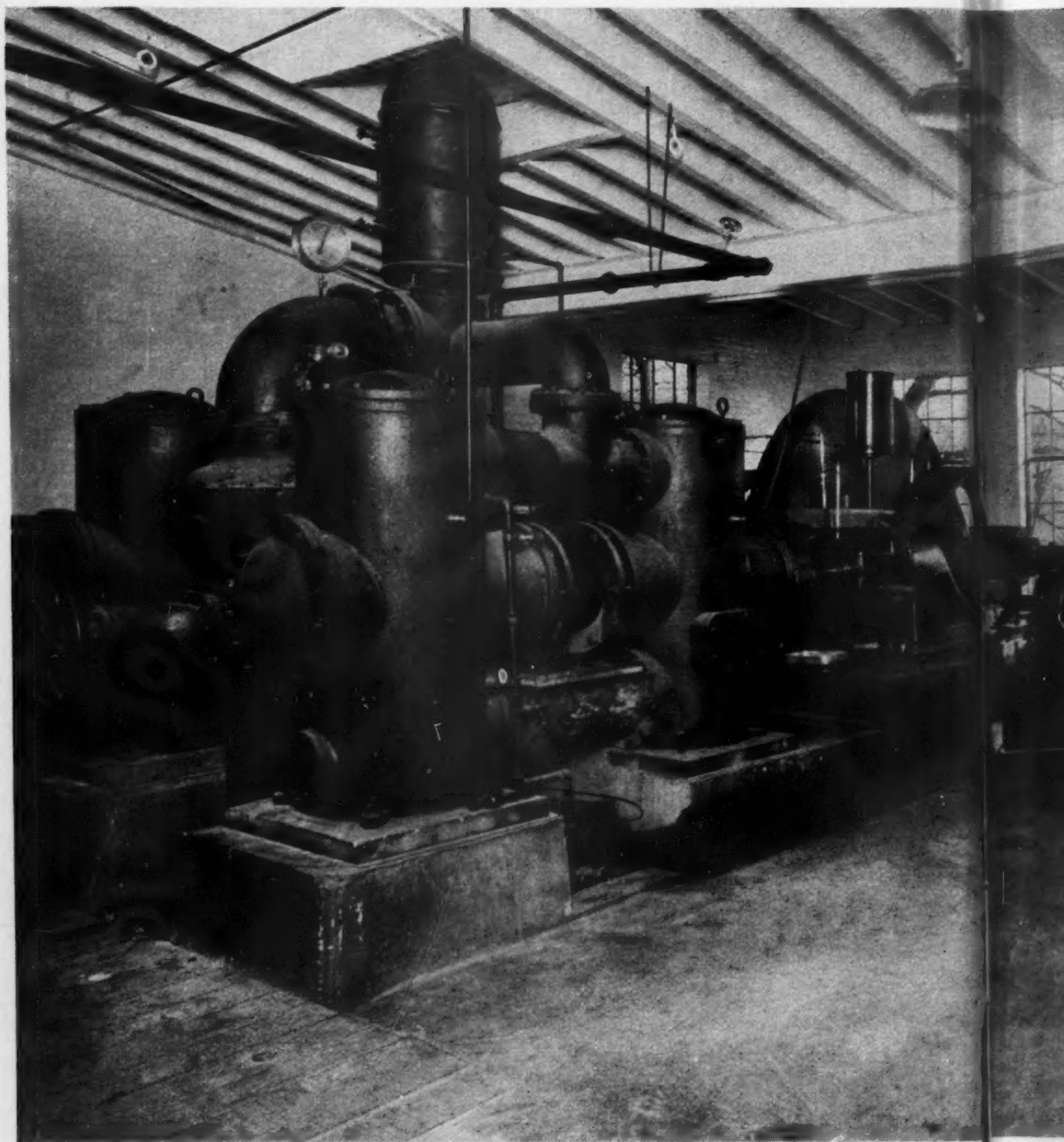
The resultant advantages are numerous. Diesel engines can be started almost instantly and will deliver their full power at

once; but when they are not in service they need no attention and consume no fuel. Furthermore, a modern diesel engine requires but a small fraction of the floor and room space occupied by a steam engine and its accessory boiler and supply of coal. Another point in favor of the diesel is that it eliminates the handling of ashes and does away with the soot and dirt that inevitably detract from the appearance of a plant that includes coal-fired boilers.

The Somerville Water Company serves approximately 15,000 persons in Somerville and the adjoining communities of Raritan and Bridgewater. Distribution is made through about 36 miles of mains ranging from 4 to 36 inches in diameter. The quantity of water pumped varies from day to day and from year to year. In 1937, the daily average was 1,712,198 gallons. The lowest daily amount was 1,320,000 gallons handled on October 31, and the highest was 2,265,000 gallons on August 4. About half of the consumers pay a stipulated annual water rate, and the others, including virtually all industrial plants, are on a metered basis.

The water is drawn from the Raritan River, although not directly, as will be explained later. It is treated with anhydrous ammonia, aluminum sulphate, chlorine, and activated char, and is then pumped into a standpipe that is 150 feet high, 25 feet in diameter, and has a capacity of 550,756 gallons. From this standpipe it flows by gravity through pressure filters and thence into one 10-inch and one 36-inch main for distribution. The filtration plant contains six horizontal cylindrical tanks, each 8 feet in diameter and 20 feet long. They utilize sand as the filtering medium and are cleaned by reversing the flow of water through them. Washing water is drawn from a separate 50,000-gallon tower, which is filled by the same pumps that supply the standpipe. It is of interest to note that this plant is reputed to have been one of the first in the country to use pressure-type filters. The original units, which were vertical, were replaced many years ago. After leaving the filters and before entering the distribution mains, the water is chlorinated a second time, the chlorine being brought up to the same pressure as the water by means of a pump.

The pumping and treatment plant is located in Raritan, on the north bank of the Raritan River. Paralleling the river is a canal that derives its water from the river



WATER-DRIVEN PUMP

This compound reciprocating pump has a capacity of 3,000,000 gallons daily and normally handles the entire load on the plant. It is driven by a water turbine, the power from which is transmitted to the pump through a vertical shaft, a set of gears, and a horizontal shaft. It is interesting to note the marked contrast in size between this pump and the centrifugal units in the pictures of the recently installed standby diesel-driven pumping sets.

at a point some 3 miles upstream from the plant. This canal was constructed more than 50 years ago and has at various times furnished hydraulic power for operating industrial plants. The Somerville Water Company plant stands between the canal and the river. As the former is at an elevation approximately 14 feet higher than the normal river level, the head necessary for utilizing the flow of the canal for power generation is already provided.

The canal water enters a power penstock through a protective grating and flows down a steep slope to a 42½-inch Sampson turbine that operates under a head of 13 feet 10½ inches. It is rated at 185 hp. at 140 rpm. The shaft of the turbine extends up into the pump room, where it is geared to a horizontal shaft that operates a Goulds compound reciprocating pump that has been in service since 1928. The two pistons of this pump are 15½ inches in diameter and have a stroke of 24 inches. The rated capacity of the unit is 3,000,000 gallons per day. As this is more than the normal daily demand upon the plant, the pump can handle the entire load. Except for a payment of $2,000 a year to the Raritan Water Company for water, it costs virtually nothing to run this hydraulic unit, and therefore it is normally operated almost continuously. At the same time, auxiliary equipment must be maintained in case it is needed. Aside from mechanical failure, this pump can be affected only by insufficient water to run it or by so great a flow in the river as to raise the level of the tailrace enough to reduce the operating head.

The Goulds pump obtains its water from a suction well that is supplied by the penstock from the canal.

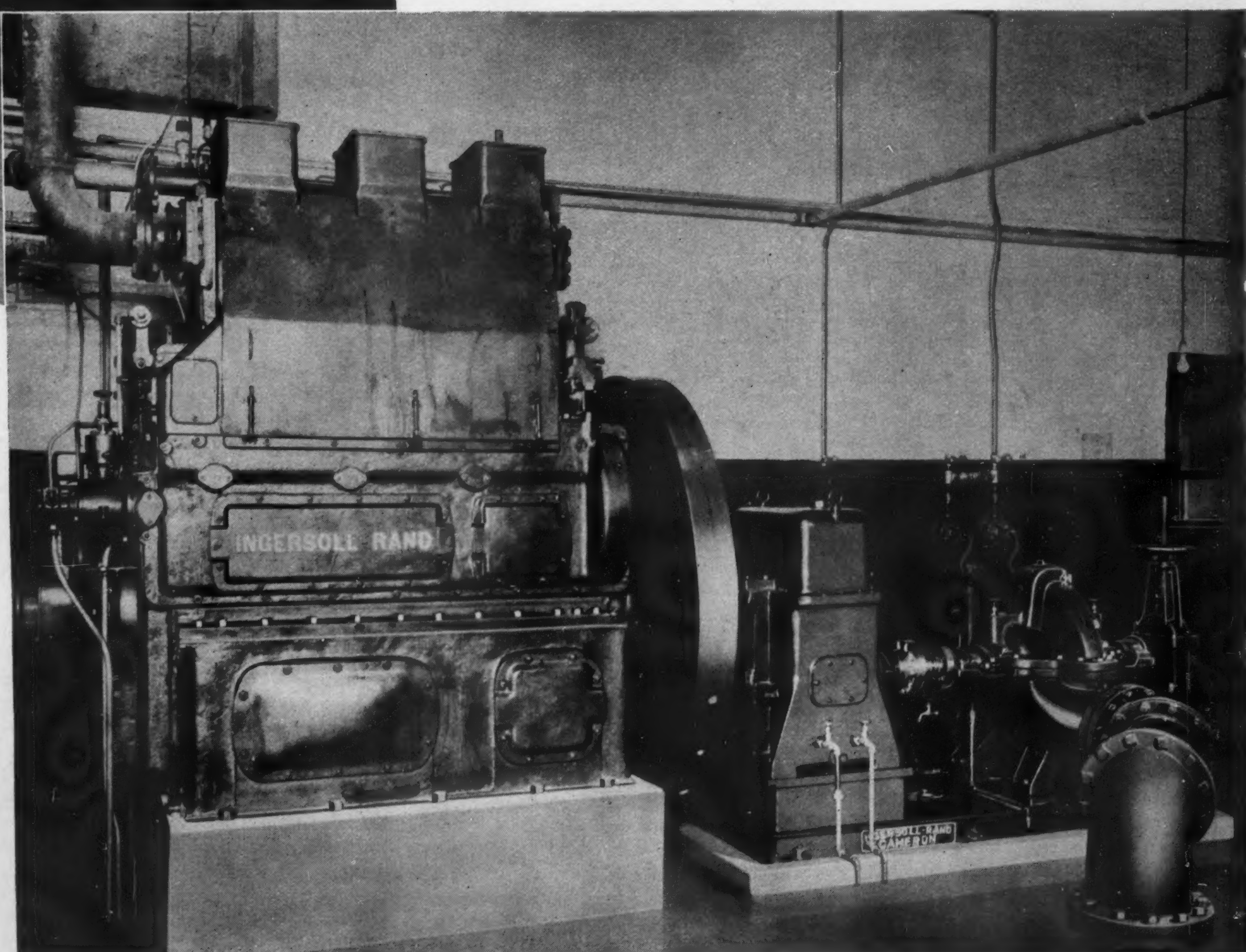
As previously mentioned, the standby pumps were until recently steam driven. One was a Smith-Vaile unit with a capacity of 2,000,000 gallons per day. It was installed in 1898. The second was a triple-expansion-type pump manufactured by the Platt Iron Works and was placed in service in 1915. It had a capacity of 2,500,000 gallons per day. These pumps were in the same room with the Goulds pump, and the plan was to utilize the same space for the diesel engines and new pumps that were to replace them. When investigations of various makes of engines were conducted, it was found that most of those offered for the service were of such dimensions that they could not be set up in the available area and that it would be necessary to tear out the lower portion of a partition wall and extend them into what was then a separate room. This was undesirable, as it would have entailed the erection of steel to form an archway sufficiently strong to support the wall structure above it.

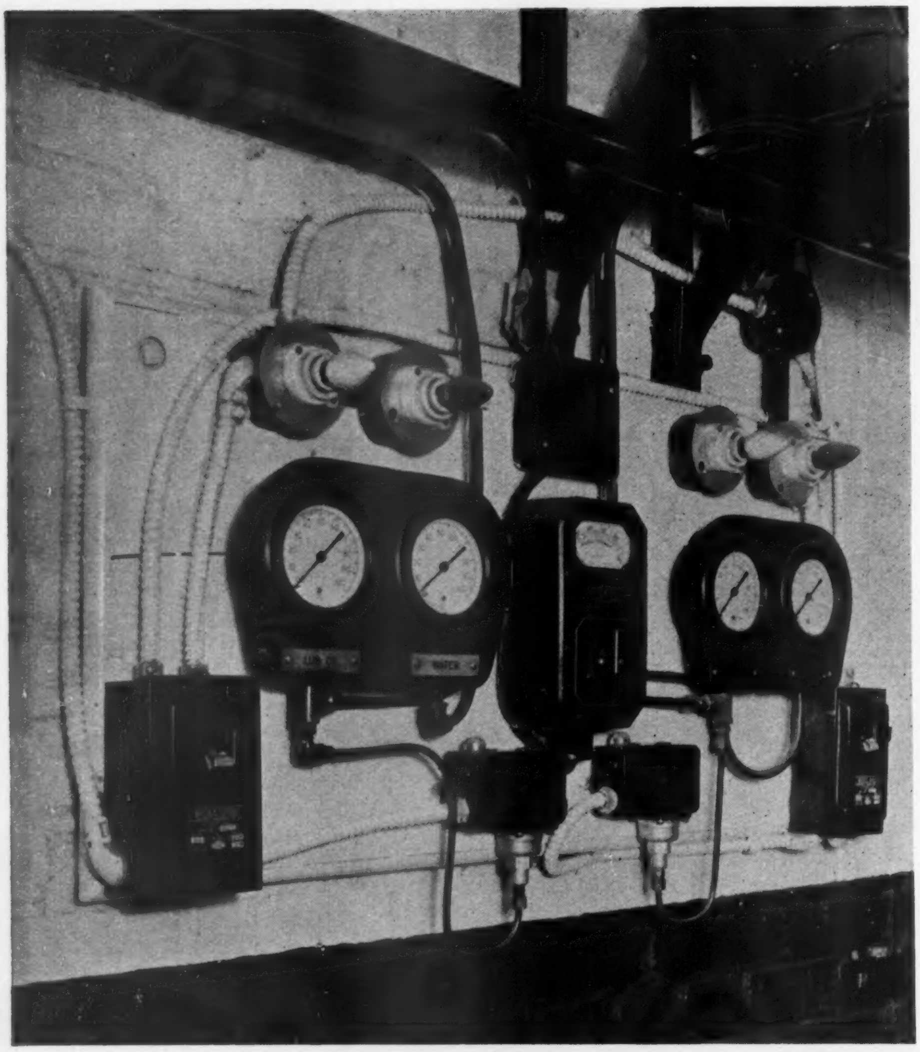
The engines eventually selected were two Ingersoll-Rand Type S units. As they had originally been designed for locomotive service, for which purpose they had to be made as compact as possible, it was found that they would fit into the available space without the need of any building alterations. Consideration, naturally, also was given to the record of this type of engine in the field of transportation in which all the units built into more than 115 locomotives since 1923 are still in operation.

Each of the engines is of the vertical, 3-cylinder, 4-cycle, single-acting, solid-fuel-injection type with 10x12-inch cylinders

SIDE VIEW OF DIESEL SET

As it was necessary to maintain standby pumping facilities while the changes in equipment were being made, one of the two steam-driven pumps was left in place while the other unit was being torn out and a diesel-driven pump erected in its stead. This picture of the first engine was made before the second one was erected. It shows details of the connections between the engine and pump. Just to the right of the flywheel is the speed-increasing gear that makes it possible to run the pump at 1,790 rpm. with an engine speed of 514 rpm.





SAFETY CONTROLS

These instruments safeguard the operation of the engines. The electric bulbs light up if either the circulating water or the lubricating oil exceeds a safe temperature, and a horn placed outside of the building blows to summon the operator. By means of the rectangular-shaped instrument in the center, the temperature of any one of the three cylinders of either engine can be ascertained at a glance.

and drives a Cameron No. 8ALV centrifugal pump at 1,790 rpm. through a De Laval speed-increasing gear. These pumps have cast-iron casings and bronze impellers. Each is rated at 2,400 gpm. against a 190-foot head, which is equivalent to 3,450,000 gallons per day.

The engines have closed cooling-water and lubricating-oil circulating systems, there being one of each for each unit. The water pumps are Cameron No. 1RVF-1½ Motorpumps. Each is rated at 50 gpm. against a head of 30 feet and circulates the water through the engine, then through a Griscom-Russell heat exchanger immersed in the suction well below, and back to an overhead 100-gallon tank which serves the pump by gravity. The oil circuit is similar, the pumps being built-in units. During each cycle the oil is cleaned by passing it through Purolator filters.

Fuel oil is fed to the engines from two 50-gallon day tanks placed overhead and against one wall of the room. A 5,000-gallon fuel-storage tank, 6 feet in diameter and 24 feet long, is located underground and outside of the building. From it the supply for the day tanks is pumped by hand as needed.

Each engine receives intake air from the roof where it enters via louvers, passes through an American Type OCH filter, and is then delivered by a 6-inch pipe to the engine. Each of these intakes is equipped with a Maxim muffler to deaden noise and pulsations. The engine exhausts are 5-inch steel pipes extending through the roof and fitted with Maxim silencers.

Compressed air for starting the engines is supplied by two Type 30 air-cooled, 2-stage compressors. One is driven by a Wisconsin air-cooled gasoline engine and the other by a G-E 3-hp. motor. Each discharges into a vertical receiver tested for 250 pounds pressure.

The engines are equipped with temperature alarm systems for both cooling water and lubricating oil. These were furnished by the Detroit Lubricator Company. Electric bulbs on the instrument board—red for oil and white for water—light up when the safe temperature of either is exceeded, and a horn, situated at a point where it can be heard throughout the plant, blows to summon the operator. By means of a Brown temperature-indicator system with thermocouples in each cylinder of each engine it is possible to ascertain at a glance the temperatures in all the cylinders.

In order to assure continued standby service while the new equipment was being installed, the engines were set up one at a time. The Smith-Vaile pump was left in place until the first diesel and its connected pump were ready for operation. This necessarily limited the working room and added to the difficulties of erection. The first unit was in position on August 12, after which the work of tearing out the second old pump was begun. The second diesel and its pump were ready for service on October 17.

The new Cameron pumps do not take their water from the suction well that is used by the Goulds hydraulically operated unit. Their water also comes to the plant by a different course. Immediately upstream from the Somerville plant is a similar water-pumping station owned and operated by the Duke Farms for supplying water to the 2,300-acre J. B. Duke estate just across the river. It contains three hydraulic turbines and an auxiliary steam plant. The tail-race of this plant runs along the riverward side of the Somerville plant and joins its tailrace. Before reaching that junction, however, some of it enters the suction well of the diesel-driven pumps of the Somerville plant through an archway cut in the lower portion of the masonry wall.

The Cameron pumps are primed by pulling water into them from the suction well by means of a vacuum induced by a water-jet exhauster. The water required for operating these jets is obtained from the standpipe. The intake to the suction well is protected by a Rex traveling water screen. Trash and other material that might interfere with the proper functioning of the pumps adhere to the screen, are thus elevated, and then washed off and into a waste drain by a stream of water that plays upon the screen near the top of its cycle.

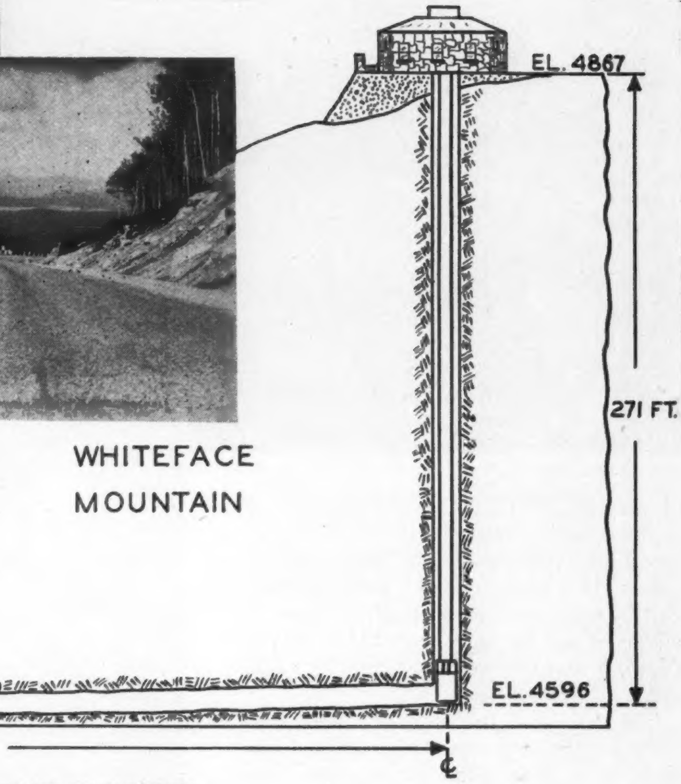
Prior to the installation of the diesel plant, an Erie 125-hp. and a Smith 150-hp. boiler were operated to supply steam for the old pumps. These were torn out when the change was effected, making available a room that has been fitted out as an office and releasing what was formerly the coal bin for storage purposes. As the steam developed in these boilers had been used for heating the plant, it became necessary upon their elimination to provide other facilities. This has been done by installing a gas-fired boiler.

The plant modifications that have been described were made under the direction of Louis L. Miller, secretary, treasurer, and engineer of the Somerville Water Company.

An Elevator for Mountain Climbers

Allen S. Park

VIEWS OF ROADWAY
The Whiteface Mountain Memorial Highway reaches a higher altitude than any other road in the Adirondacks. It is a 2-lane highway with wide curves. At its terminus, 273 feet vertically below the summit, stands Whiteface Mountain Castle (above) in which is a restaurant and other facilities for the accommodation of visitors.



A BOON TO MOUNTAIN CLIMBERS
Sight-seers will leave their automobiles near the portal of the adit, walk into the mountainside 424 feet on a slight incline, and then enter a modern elevator to be whisked to the top of the peak. They will step out inside the summit house, a rustic, stone structure surrounded by a terrace from which, on a clear day, they may see as far as Mount Royal, Montreal, Canada. Whiteface Mountain is the highest peak in the Adirondacks that can be ascended by automobile.

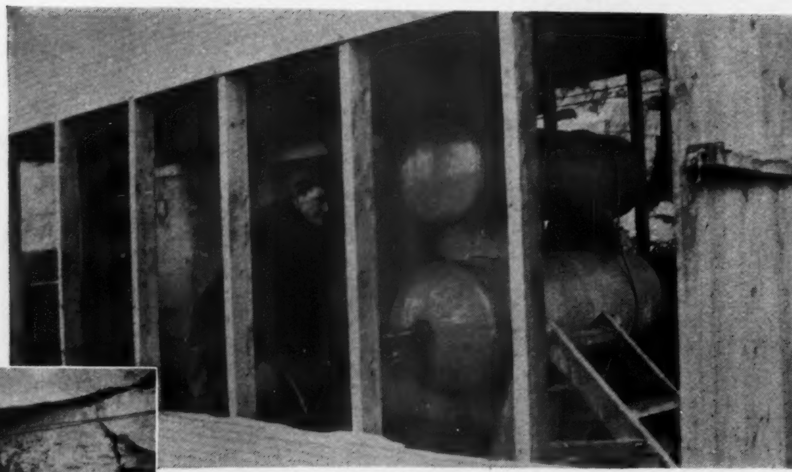
AN UNUSUAL piece of construction work has recently been completed at the summit of Whiteface Mountain in northern New York. It consists of an adit 424 feet long and, from its terminus in the interior of the mountain, of a 271-foot vertical shaft in which an elevator will run to the top of the peak. These facilities for reaching the summit were provided because the topography makes it unfeasible to carry the existing road to the top—insufficient space being available there for the parking of cars.

Whiteface Mountain rises 4,867 feet above sea level and about 3,000 feet above Lake Placid, at the head of which it stands. It is the eighth highest peak in the Adirondacks and the loftiest in that chain that can be ascended by automobile. It received its name because of a slide on one of its slopes that exposed the gray-colored rock formation. The Iroquois Indians called it Theanoguen, which name they also applied to King Hendrik of Revolutionary times because he had a white patch of hair that led them to associate him with the mountain. The Algonquin name for the peak was Wahopartenie, meaning "it is white."

The roadway up the mountain is known as the Whiteface Mountain Memorial Highway and was conceived as a memorial to the World War dead of New York State. It was built by a commission that was appointed by Franklin D. Roosevelt when he was governor of New York and under authority given him in a bill passed by the State Legislature. This commission was empowered to issue bonds to finance the construction, which cost approximately $1,100,000. Mr. Roosevelt turned the first shovelful of earth on September 11, 1929, and actual work was begun on Christmas Day of 1931. The road was opened to travel on July 20, 1935, and was dedicated by President Roosevelt on September 14 of that year. It is operated on a toll basis, but will become a free route when the outstanding bonds have been retired.

The highway was built by the Hagadorn Construction Company of West Virginia, which is credited by the commission with having done an excellent piece of work. It starts at Wilmington, N. Y., and is 8 miles long. It is 24 feet wide, of which 20 feet is surfaced with macadam. The average grade is slightly more than 8 per cent and the maximum is 10 per cent. Curves are wide and are well protected by retaining structures.

The road ends at a point 273 feet vertically below the summit where there has been erected a stone structure, known as Whiteface Mountain Castle, that houses historic and scenic exhibits, a restaurant, and other facilities for the accommodation



ADIT PORTAL AND COMPRESSOR

Entrance to the adit through which the operations were conducted, and the 315-cfm., air-cooled portable compressor that supplied the air necessary for the work.

THE ONLY CASUALTY

This horse, shown on the ramp that was built to enable it to make the initial stage of the climb, transported a derrick and other essential equipment from the road to the top of the peak. The animal contracted pneumonia working at the high altitude and died after being taken down the mountain.

of visitors. Until the recent project was completed, the remainder of the trip to the top of the peak had to be made by foot over a steep pathway and a series of steps. But as some persons, particularly those of advanced age, were severely taxed by this climb, it was decided to provide an easier way of reaching the crest.

The adit and the elevator shaft were built by the Centaur Construction Company of 11 West 42nd Street, New York City, under a contract calling for an expenditure of approximately $125,000. Work was begun in August, 1936, but severe weather conditions enforced a halt the following November. Operations were resumed in May, 1937, and were substantially concluded last November.

The adit enters the mountainside at elevation 4,583 and advances on a slight grade, its terminus being at elevation 4,596. From that point the elevator shaft rises straight upward a distance of 271 feet. At the top is a summit house of stone. It is almost circular in plan, 41 feet in diameter, and 22 feet 3 inches high. Surrounding it is a terrace paved with flagstones and supported around its outer edges by a dry masonry wall. This wall extends 3 feet above the level of the terrace and has openings at intervals of 20 to 30 feet.

The procedure followed by the contractor was to drive the adit its full length and then to excavate the elevator shaft from the bottom upward, with the exception of the top 50 feet. The latter section was sunk in order to obtain rock for the summit house, terrace, and walls, thus permitting work on the surface structures to be carried on at the same time operations were in progress in the interior of the peak.

Because of the precipitous character of the mountain top, numerous difficulties had to be overcome to get work going at the summit. A derrick had to be set up there for hoisting the broken material from the shaft, and this was transported, piece by piece, by a horse. To enable the animal to ascend the steep bank alongside the roadway that had been cut in the side of the mountain, it was necessary to construct a ramp. The horse rendered faithful service and delivered all the required plant at the top; but, after being taken down the mountain, it fell a victim to pneumonia and died.

The adit is 5 feet wide and 7 feet high. It was driven with two Ingersoll-Rand DA-30 drifter drills equipped with automatic feed. These machines were mounted on columns and arms. Drilling was done with Jackbits and rods, approximately 10,000 bits being required to complete the adit and shaft. They were resharpened twice, so each bit was used three times before being discarded. The rock, which is of igneous origin and classified as a gabbro, proved to be very hard, and only about 2 feet could be drilled with a bit. Various types of drill rounds were tried out in the adit, and an average of 22 to 24 holes, carried to a depth of 5 feet, was drilled per round. Blasting was done with Hercules 60 per cent dynamite, and a total of 20,000 pounds was used. Firing was done electrically; and the broken material was hand-loaded into small railroad cars which were run out of the adit by gravity while the empties were pushed back in.

After the adit had been driven, the work of raising the 11½-foot-square elevator shaft was begun. This operation is a common one in mining districts; but in the general contracting field it is decidedly unusual. Despite its unfamiliarity with a job of this kind, the Centaur organization carried it out successfully and without injuring a man. The workers wore hard hats, and everything was done to promote safety.

The general plan was to divide the shaft into a manway and a muck passage, the latter taking up, roughly, two-thirds of the area of the opening. Timbers were placed across the shaft at the dividing line, cross-braced against the near wall, and lagging was carried upward as excavating proceeded. The muck passage was kept filled at all times, the material being drawn from it through a chute at the bottom as required to keep the top at the desired level. By this arrangement it was possible to make the necessary set-up for drilling in that section of the shaft on top of the muck column, while the drills over the timbered

WHITEFACE MOUNTAIN SUMMIT

The tower shown has now been replaced by a rustic, stone summit house. The adit leading to the elevator extends into the mountainside from a point near the lower left.

section were set up on planks. Shaft drilling from below was done with two automatically rotated Stopehamers of the Ingersoll-Rand SAR-120 type. The sinking of the top 50 feet was done with an S-58 Jackhamer.

Compressed air for the job was supplied by an Ingersoll-Rand 315-cfm., 2-stage, air-cooled portable compressor. In addition to operating the drills, air was used for pumping water to them. All water had to be transported over the road from a point 2 miles down the mountain. Pumping was done by partway filling a closed tank with water and by applying air pressure on top of it. This sufficed except when the drills were working in the upper section of the shaft, and then it was necessary to do the pumping in two stages. For this purpose another tank was stationed at a level 150 feet above the shaft bottom and partly filled, after which compressed air was applied to the free surface of the water, thus raising it the remainder of the distance.

Although Whiteface Mountain is not high in comparison with western peaks, it is nevertheless exposed to severe weather in winter, and even in the summer season the temperature at times drops to near freezing. When representatives of the contracting firm went to the mountain top on July 4, 1936, to inspect the scene and to make plans for conducting the work, they had the novel experience of being caught in a midsummer snowstorm. When operations were resumed in May, 1937, following the winter shutdown, the adit was found to be plugged with ice for a distance of 80 feet, and this had to be removed before work could proceed.

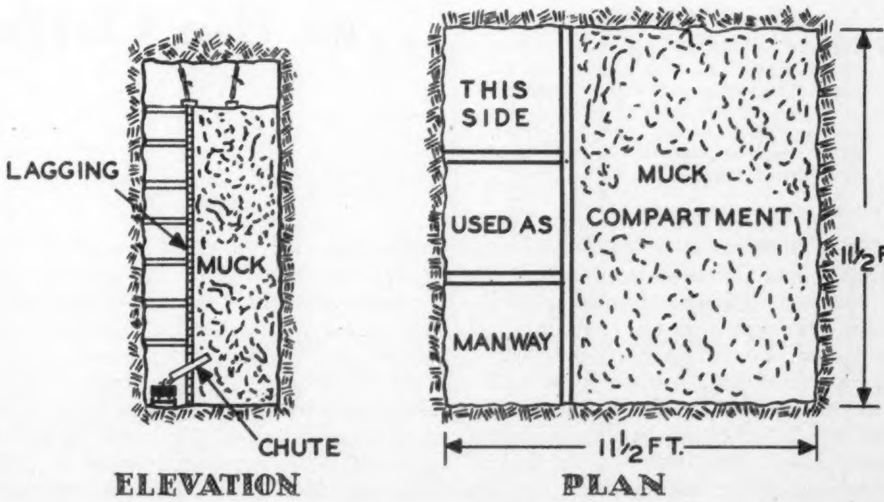
The elevator that will carry sight-seers up the final stage of the mountain ascent was put in by the Otis Elevator Company. It has a capacity of fifteen persons. Passengers will step out of the car inside the summit house. This structure contains little in the way of furniture, but it has been provided with a large fireplace of stone that will doubtless be put to considerable use.

New York University, Rensselaer Polytechnic Institute, and the U. S. Government are jointly operating a weather station that is located on top of the peak; and in the summit house there is a small glass-inclosed room for the instruments and a desk for the meteorologists. Two university students are spending the present winter on the peak as weather observers.

The drive up the mountain has proved very popular with tourists ever since the highway was inaugurated, and more than 2,500 persons have made the ascent in one day. The road is ordinarily open from May 15 to November 1, the exact dates depending upon weather conditions. The summit affords an extensive view of the surrounding country. On clear days, Lake Champlain, the St. Lawrence River, the Green Mountains in Vermont, and even Mount Royal in Montreal, Canada, can be seen. All these points and many others can be brought closer to the eyes by means of telescopes which are available for the purpose.

The work described has been done under the direction of the Whiteface Mountain Memorial Highway Commission, consisting of W. H. Anderson of Troy, chairman; J. Hubert Stevens of Lake Placid, vice chairman; Roger B. Prescott of Keesville, treasurer; and Edward J. Fitzgerald of Troy, secretary. Frederick Stuart Greene, New York State Superintendent of Public Works, served as engineer.

In view of the unusual character of the facilities for reaching the summit, it is of interest to note that a similar undertaking was recently completed in Switzerland in order to give access to a new meteorological observatory at the top of the Sphinx—one of the peaks of the Jungfrau—at an altitude of 11,700 feet. An adit extends into the mountain from the railroad terminus, and from the far end of this adit rises a vertical shaft, approximately 350 feet high, in which operates an elevator. The car accommodates twelve persons and makes the trip to the summit in 2½ minutes. In driving the adit and in excavating the shaft considerable water was encountered, and it was necessary to grout the surrounding rock extensively to correct this condition. Fortunately, in the American instance, the rock proved to be sound, and no grouting was required.



HOW THE SHAFT WAS RAISED

By erecting timbers, the shaft was divided into two compartments. The smaller one served as a manway and contained the compressed-air pipes, electric conduits, etc. The larger one was used for muck disposal and was kept filled to a level that would permit setting up the drills on top of it, the material being drawn off into cars as required through a chute at the bottom. Although the contracting firm had never performed work of this nature before, the job was completed successfully and without injuring a workman.

BIT-DRESSING ROOM

Bits are normally reground five times, which means that each one is used six times. They are dressed on five electrically driven grinders each of which has a forming wheel and a gauging wheel. Every operator grinds about 140 bits in an 8-hour day.

Detachable Bits at the Cliffs Shaft Mine*

C. J. Stakel†

THE Cliffs Shaft Mine of the Cleveland-Cliffs Iron Company is located on the Marquette Range at Ishpeming, Mich. It has been operated for more than 50 years, and is now equipped to produce 500,000 tons a year. There are two 1,000-foot-deep vertical shafts, "A" and "B," from which fifteen levels, approximately 50 feet apart, have been cut, the first of these being 350 feet underground. The ore, a hard specular hematite, occurs in a synclinal or trough-shaped formation, which, because of folding and faulting, is very irregular. Displacements of strata have separated the ore into a number of individual bodies or lenses, and to reach these a great amount of drifting and raising must be done. The ore is overlain by quartzite and slate and underlain by jasper in some places and by siderite (iron carbonate) and diorite in others. The ore, jasper, and siderite, are all very hard, making the drilling problem a serious one. The drilling machines are of the drifter type, with pistons 3¼ and 3½ inches in diameter. In stopes they are usually mounted on tripods. All drills are operated with air at a pressure of 90 pounds.

Until 1934, all underground drilling was done with conventional 1¼-inch hollow drill steel. In that year it was decided to make a series of tests with detachable bits. These were started in both rock and ore, two contracts being selected in each of the two shafts. Detachable bits and conventional steel were used on alternate days, thereby providing conditions favorable to the making of a direct and conclusive comparison. By these tests it was determined that detachable bits would increase drilling speed—and, incidentally, footage of hole per shift—and reduce drilling costs. As a result of these findings it was decided to replace conventional steel with detachable bits and drill rods throughout the mine. This was done gradually so as to dispose of the supply of steel on hand and also because it was desirable that the miners should know how to use detachable bits before making the change. The first replacements were made on development contracts where an appreciable proportion

*Digested by permission from a paper prepared for the Lake Superior Mining Institute.
†Superintendent, Cleveland-Cliffs Iron Company.

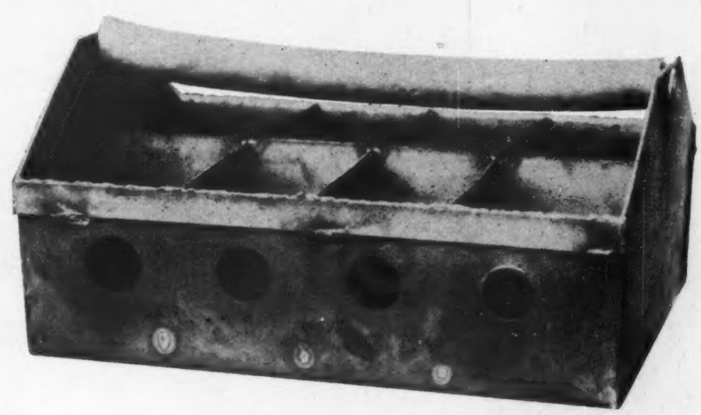
of the miners' working time was consumed in transporting steel.

A shift boss and a miner who had had experience with detachable bits were delegated to teach the miners exactly how to attach and to detach the bits from the rods, particular emphasis being placed on the performance of these operations in a manner that would not damage the skirt or upper part of the bit, which is comparatively soft. The men were also cautioned not to wear a bit down so far as to seriously impair its cutting capacity because of the consequent reduction in drilling speed, high regrinding and resharpening costs, increased air consumption, and excessive wear and tear on the drilling machine. Likewise, they were shown how to gauge reground bits correctly, and impressed with the importance of keeping the threaded end of each drill rod covered with a discarded bit to prevent damage to the threads. The instructors normally spent a week with the miners on each contract before leaving them to their own devices; but the period was lengthened whenever the men required further training to attain the desired proficiency.

Every working place is provided with a metal box divided into eight compartments, each of which is for bits of a certain gauge. In the outer wall of each compartment there is a hole, and this serves as a gauge for the size of bit to be kept in that compartment, the gradation in gauge sizes being 1/16 inch. The miner always keeps this box near him when he is drilling. Each mining contract also is furnished with another set of metal boxes, 14 inches long, 6 inches wide, and 5 inches deep, in which to transport dull bits to the shop for redressing and sharp bits to the working place. These boxes are marked on the end with the contract number and on the cover with the level number and the shaft in which the contract is located. They are provided with handles to facilitate carrying them.

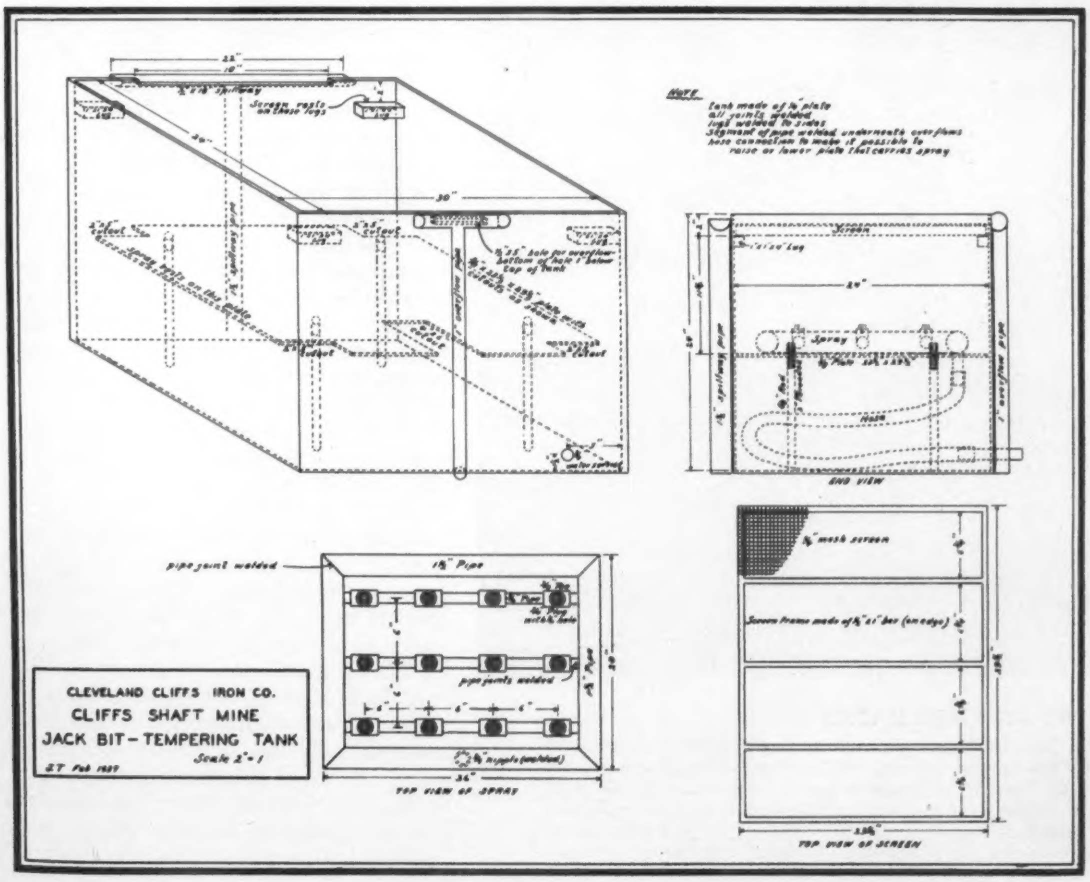
Dull bits are delivered to the shop each morning, and are dressed, returned to their respective boxes, and sent back to the mine the same day. Discarded bits are replaced with new ones. Meanwhile, each miner has a supply of bits underground in a spare box, and if the ground is exceptionally hard, he is given still another one. When filled with sharp bits ready to go underground, the boxes are arranged according to shafts on shelves. Each working place or contract usually has an average of about 65 bits and twelve drill rods per drilling machine. Every miner is provided with a soft or annealed steel hammer with which to tap the bits on or off the drill rods.

Bits are redressed on five grinders. Four of these use 1½x12-inch forming wheels and 1¾x12-inch gauging wheels. The fifth one is a semiautomatic machine. It is equipped with 16-inch-diameter wheels. The faces or wings are ground until the cutting edge extends the full width of the gauge desired, after which the diameter of the bit is ground to gauge. The number of re-



BOX FOR BITS

Each working place is furnished with one of these metal containers (right) in which sharp bits are kept. The box is 18¼ inches long, 13½ inches wide, and 9¼ inches deep. It is divided into eight compartments, each of which is for bits of a specified size. In the outer wall of each compartment is a round hole that serves as a gauge for the bits in that particular compartment.



DETAILS OF BIT TEMPERING TANK

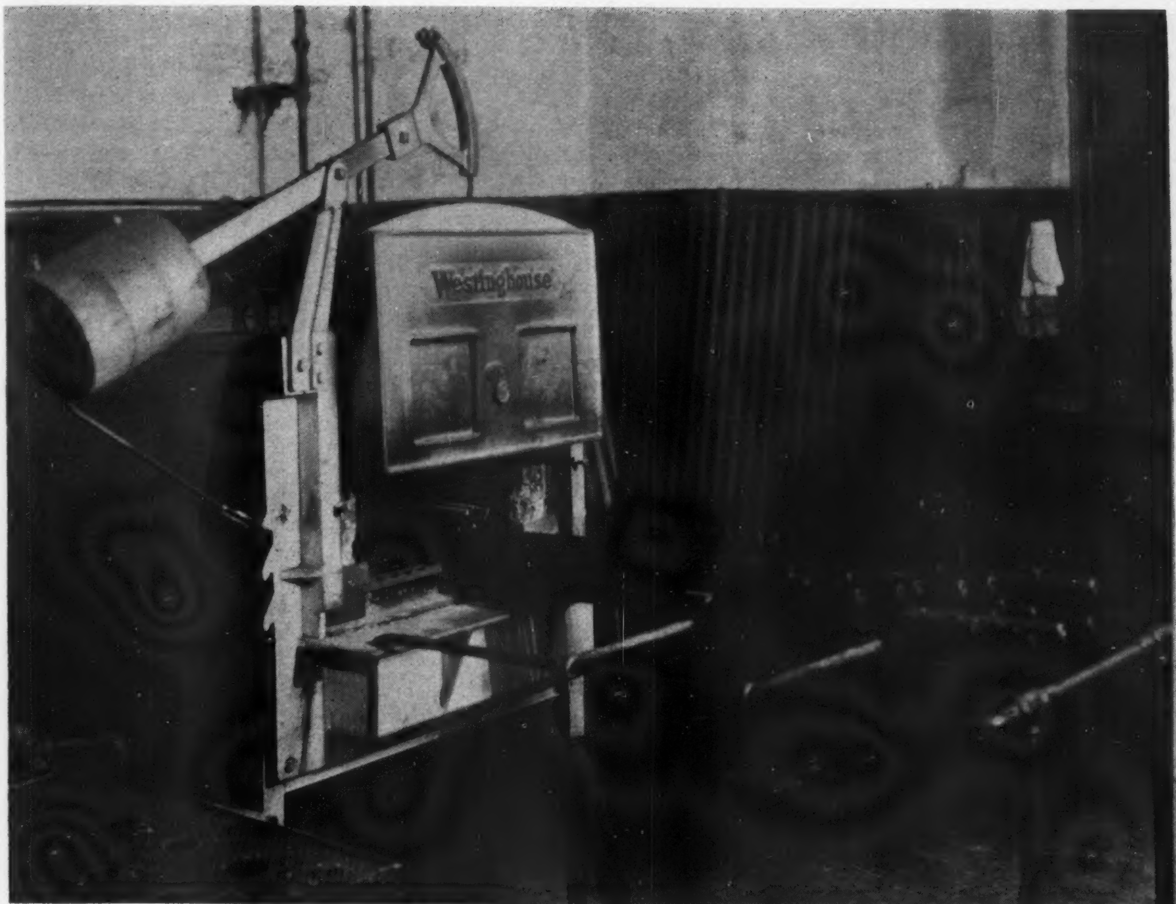
BIT AND ROD RACKS

Bits are transported to and from the working places in special metal boxes each of which has a cover and a handle to simplify carrying it. On the end of each box is marked the number of the contract for which it is designed, and on the cover are the shaft and the level numbers of the contract. These boxes are filled with sharpened bits and placed on shelves to await transportation underground. Nearby are racks containing drill rods, the different lengths being put in separate divisions.

grinds is usually five—that is, each bit is normally used six times before it is discarded. From time to time it is necessary to true up the angle of the face of the forming wheels and to square up the face of the gauging wheels. These operations are performed with a special dressing tool.

After bits are sharpened, any that show evidence of being worn down to the point where little of their hardened surface remains are put in a special container to be rehardened. After a sufficient number of them has accumulated, they are placed in an electric furnace, 75 at a time, where they remain for 30 minutes at a temperature of 1,450°F. This furnace is of the muffle type, and the heating compartment is 36 inches deep, 18 inches wide, and 12 inches high. It uses single-phase, 220-volt, 60-cycle current, and is equipped with a thermocouple and leads and temperature-control fuses, the maximum heating capacity being 1,850°F. A Leeds-Northrup automatic recording pyrometer, connected with a clock, enables the operator to set the switches each day when he leaves so that the furnace temperature will be at the desired level when he returns the following day.

During the heating of the bits, a little powdered charcoal is put inside the muffle of the furnace to maintain a reducing temperature and thus to prevent decarbonization. The heated bits are extracted, two at a time, until twelve have been removed. As the opening of the door usually causes the furnace temperature to drop about 15°,



the door is closed and the temperature allowed again to reach 1,450° before the next twelve bits are withdrawn.

The heated bits are quenched in cold water in a tank of special construction. Near its bottom is a manifold with twelve water jets turned upward. Because of their geyserlike action, these jets set up a turbulence in the water that is very necessary to prevent the formation of insulating steam pockets that would keep the water away from certain parts of the bits and, consequently, produce soft spots on the cutting edges. The bits are placed, cutting edges downward, on a tray that can be raised or lowered so as to give them the submergence necessary for their proper tempering, the tray usually being positioned so that the water will reach a point three-fourths of an inch up from the face of the bits. Too deep a submergence will make the skirt of a bit so hard that it will damage the threads of drill rods which, in turn, will damage the threads of bits. Too shallow a submergence results in soft cutting edges. The quenching tank has an outlet in each of its four sides to carry away the water that is introduced by way of the jets, thereby insuring a fast flow and cool water in the tank.

When the bits are blue-black in color, they are removed from the quenching tank and submerged in boiling water, where they are allowed to cool. One bit from each lot is cut in two with a narrow abrasive wheel in a shank grinder, is etched by immersing

HEAT-TREATING EQUIPMENT

An electric furnace that can develop a temperature of 1,850°F. is provided for the heat treatment of bits and the threaded ends of drill rods. Bits are heated, 75 at a time, for 30 minutes at a temperature of 1,450°F., and are then quenched in water in a tank of special construction, as shown at the left of the furnace. The threaded ends of drill rods are heated at a temperature of 1,500°F. for an hour, after which they are quenched for seven seconds in cold water and next in oil. Following that, they are heated to 750°F. and allowed to cool in the open air.

it in sulphuric acid for three minutes, and is then examined to make sure that the hardness has reached the desired depth. After they have been thus checked, the bits are placed in storage bins ready to be sent back into the mine. From 300 to 350 bits are usually retempered during an 8-hour shift. The shop force is made up of a foreman, who operates the electric furnace and quenches both bits and rods, and four men who operate the grinders. Each man grinds about 140 bits in an 8-hour day.

The shop also includes equipment for making up and reconditioning drill rods. New steel received from the manufacturer is cut into suitable lengths with a power saw. Shanks and lugs are formed in a conventional drill-steel sharpener, the heating being done in an oil furnace. The shanks are tempered by heating them, 24 rods at a time, in the electric furnace. There they remain at a temperature of 1,480°F. for an hour. Twelve inches of the rod end is heated, the heat overlapping that applied in the oil furnace when the shanks were formed. After being heated, the shanks are quenched in oil and permitted to cool. The quenching tank is water-jacketed and has a capacity of three barrels of oil. About 150 rods are usually treated in an 8-hour shift. The end of the rod to be threaded is heated and placed in lime to anneal the steel. Threads are formed in a machine that trues up the end and the diameter and cuts four left-hand, 250-pitch threads to the inch. This work is done slowly enough to insure a good thread, as experience has shown this to be vital to the success of detachable bits. Poor threads cause no end of trouble underground.

The hardening of threads is done in the following manner: The electric furnace is brought to a temperature of 1,500°F., and not more than 24 rods are placed in it. After the temperature has again reached 1,500°, it is held at that point for one hour. The rods are then extracted, one at a time, and the heated end submerged first in water for seven seconds and then in oil. The rods are later returned to the furnace and kept at a temperature of 750° for one hour, after which they are removed and allowed to cool to room temperature. The usual practice is to give rods the 1,500° treatment one day and the 750° treatment the following day. The maximum number of rods so handled is 150 in two days.

The detachable bits used and as they come from the manufacturer are of two sizes—2 inches and 2⅛ inches. The larger bits serve to start holes in the hardest ground. All are of the 4-point type, with a 105° cutting angle, a 3½° taper, and wings ⅞ inch wide and ¾ inch long. The first experiments in very hard jasper and siderite were based on the theory that the pulverized material in the bottom of the hole actually did some of the cutting as it was moved around over the face of the rock by the wings of the bit. Accordingly, the earlier bits had a very slight groove between the wings. This theory was later disproved, and the bits now employed have a deep groove between the wings to permit the cuttings to escape more readily. All the drill rods used in this mine are 1¼ inches in diameter; but some 1⅛-inch and ⅞-inch hexagon rods are treated for other mines.

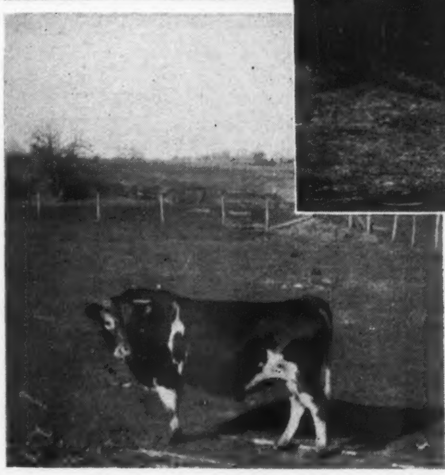
The adoption of detachable bits has resulted in a material saving in the cost per foot of hole drilled. Contributing reasons are the reduction in the size of the starting bits and the improved quality of the bits as compared with those forged on conventional steels. The detachable bit is a better drilling bit because it contains a higher percentage of carbon than ordinary drill steel. This gives the bit harder cutting edges which are more resistant to wear and, accordingly, have a longer service life. The introduction of a thermostatically controlled electric furnace makes it possible to temper bits more uniformly.

An added saving has been effected because of the reduction in the expense of transporting steel. In a large mine such as this one, where the working points are widely scattered, this advantage is especially pronounced. Prior to the adoption of detachable bits, between 69 and 70 tons of steel was distributed throughout the mine, and a considerable proportion of each miner's working day was spent in transporting it to and from the sharpener shop. The amount of steel in use has been reduced to from 10 to 12 tons. The average number of drill rods per drilling machine now is twelve, as compared with the 65 pieces of steel formerly required. Under the old system, the average contract needed from seven to eight sets of steel ranging from 2 to 12 feet long. Changes in gauge of bits running from 2⁹⁄₁₆ inches down to 1⁵⁄₈ inches were made every 9 inches. The twelve rods which are now furnished each contract are usually of the following lengths: 2 feet, 2½ feet, 3 feet, 4 feet, and so on up to 12 feet.

The greatest saving with detachable bits is naturally made where the ground is hardest and transportation most difficult. In ordinary ore stopes the increase in efficiency is approximately 10 per cent, but in the development contracts it ranges from 35 to 140 per cent. Actual instances of increased efficiency are shown in the following data, which represent averages of results obtained on certain contracts over a period of from four to six months:

	Detachable Bits	Conventional Drill Steel
Contract A		
Formation: Hard steel ore		
Operation: 10x10-foot drift		
Inches drilled per minute (cutting time)	2.90	1.77
Inches drilled per bit dulled	10.35	8.99
Number of bits per foot of hole	1.16	1.33
Gauge of starting bit, inches	2.00	2.56
Size of machine drill, inches	3.50	3.50
Contract B		
Formation: Cherty, abrasive siderite		
Operation: 8x8-foot drift		
Inches drilled per minute (cutting time)	2.98	1.69
Inches drilled per bit dulled	9.15	7.91
Number of bits per foot of hole	1.32	1.51
Gauge of starting bit, inches	2.00	2.56
Size of machine drill, inches	3.50	3.50
Contract C		
Formation: Siderite and diorite		
Operation: 10x10-foot drift		
Foot of advance in heading per miner per shift	2.62	1.90
Cost per foot drilling labor plus explosives	85%	100%
Average daily wage	120%	100%
Contract D		
Formation: Siderite		
Operation: 7x7-foot raise		
Foot of advance in heading per miner per shift	2.09	1.55
Cost per foot drilling labor plus explosives	72%	100%
Average daily wage	111%	100%
Contract E		
Formation: Siderite		
Operation: 8x8-foot drift		
Foot of advance in heading per miner per shift	2.29	1.55
Cost per foot drilling labor plus explosives	90%	100%
Average daily wage	119%	100%
Contract F		
Formation: Siderite and diorite		
Operation: 10x10-foot drift		
Foot of advance in heading per miner per shift	2.22	0.93
Cost per foot drilling labor plus explosives	61%	100%
Average daily wage	121%	100%
Contract G		
Formation: Siderite and steel ore		
Operation: 8x8-foot drift		
Foot of advance in heading per miner per shift	1.65	0.93
Cost per foot drilling labor plus explosives	69%	100%
Average daily wage	116%	100%

Cattle Waste Pumped Over Farm



SCENES ON THE FARM

At the top right is a general view of the milking barn, with the reservoir for waste liquid and the pump house in the foreground. The center picture shows the reservoir (left) and the pump house at close range. At the top left is the discharge pipe the horizontal arm of which may be turned so as to send the flow in any direction. The other views picture some of the cattle on the farm.

A PUMPING system that makes it possible to utilize cattle-barn waste material as a farm fertilizer at small expense has been worked out and placed in operation by R. B. Gilbert, owner of a 600-acre dairy farm at Ten Mile, Tenn. The floors of the barn in which the cows are milked are regularly washed clean with a stream of water. The drainage flows into a concrete reservoir 10 feet wide, 20 feet long, and 5 feet deep. Formerly this was discharged from the reservoir into a small stream; but it polluted the water and thus rendered it unpotable.

On a trip to Germany, Mr. Gilbert saw similar waste being put to beneficial use, and that gave him the idea for the scheme that is now in effect. The liquid is pumped through 370 feet of 2-inch galvanized pipe to the top of a hill, which is 37 feet higher than the bottom of the reservoir, and distributed over the farm by gravity flow. As will be noted in one of the pictures, the fertilizer issues from a short length of horizontal pipe that is connected by an elbow to a vertical pipe. This connection is made loose so that the pipe can be swung around at will and the liquid discharged in any direction desired. By laying wooden troughs on the ground it can be conveyed to other parts of the farm.

For this pumping service, Mr. Gilbert installed a Cameron No. 1-ORVF-1 Motorpump that has a capacity of 25 gpm. against 57 feet of head. It is operated at 3,450 rpm. by a G-E motor that uses 110-volt, 60-cycle, single-phase current. To strain out coarse material, the pump suction in the concrete reservoir is protected by a heavy ½-inch mesh screen. There has also been interposed in the discharge line near the pump a Y fitting and a gate valve with a plug for a clean-out connection in the event the pipe line or pump becomes clogged. But despite the fact that considerable solid material is being pumped, no trouble has so far been experienced in handling it.

Although temperatures as low as 10°F. have been registered this winter, freezing weather has not stopped the pump from operating. To guard against such a contingency, it was planned to hang an electric light close to the pump and to burn it during severe cold spells; but to date no need for this precautionary measure has arisen.

THE FUTURE LINER

MARINE engineers foresee the early construction of transatlantic ocean liners much larger than any now in service. Their coming is inevitable, these engineers say, because only such huge ships can compete successfully with the airplane. In an article published in *The Engineer*, London, Messrs. Pierre de Malglaive and A. C. Hardy have visualized one of these future superliners.

Assuming that flying craft will provide 60-hour service between Europe and the United States, it is contended that, to be competitive, ship service must be cut to 84 hours, or $3\frac{1}{2}$ days. This will call for a speed of 35 to 37 knots, as compared with the approximately 30 knots now attainable by the *Queen Mary* and the *Normandie*. Such a speed will be possible only with a longer hull. The authors predict a length of 1,350 feet, which is slightly more than a quarter-mile.

For operating this mammoth, they will provide a power plant capable of developing about 400,000 ship horsepower. This will be distributed among six propellers, three on either side of the center line. The utmost economy of space utilization must be practiced to house so much power in the vessel. Investigation shows, according to the authors, that turbo-electric drive is the only method of propulsion that will meet these conditions. They propose to have six turbo-alternators, each complete with its boiler. Oil will be the fuel, and it is computed that 2,150 tons of it will be consumed daily and that 11,000 tons of it will have to be stored aboard. Three thousand tons of boiler feed water will also be carried. To preserve the correct trim of the ship, provisions will be made for ballasting the tanks with sea water as the fuel is withdrawn.

The superstructure of the ship will be streamlined and glassed over to assure calm and comfort in any kind of weather. Air will be taken in through a grilled opening at the forward end and distributed through ducts. Smoke and flue gases will be run out at the back or even underwater when at sea, but stacks will be provided for their disposal when in port.

These are a few of the principal features of the dream liner of not so far off. Its draft will have to be shallow enough to permit using existing channels; but it is proposed to build special terminals and to pay increased attention to rail, air, and highway connections. It is also intended to expedite the handling of baggage and to speed up customs inspection. It is pointed out that it is useless to gain time at sea if much of it is to be lost in disembarking.

The projectors of this supership believe that many persons will patronize it in preference to the airplane for the reasons that it will give them increased safety and comfort and, at the same time, insure a quick crossing. They propose to have only two classes of accommodations—cabin and tourist.

RIVET STANDARD

AFTER eleven years of work, a standard for large rivets has been drawn up and approved by the American Standards Association. It covers rivets of $\frac{1}{2}$ inch to $1\frac{3}{4}$ inches nominal diameter, and includes the dimensions not only of the driven shapes of four of the six types of rivets but also of the corresponding dolly bar and rivet-set impressions.

The effect of the standard has been to reduce greatly the many forms of rivets that were formerly made. Apparently many of them had no basis for existence other than that they were someone's arbitrary whim or random selection. As a result of the simplification, one rivet manufacturer has been able to reduce his stock from 20,000 tons to 5,000 tons.

One of the strange discoveries of the committee in charge of the study was that some rivet manufacturers appeared not to know of the demand for the high button-head or acorn type of rivet, and this in spite of the fact that they have been available for many years and that four large bridge companies used 28,000 tons of them in 1931. As this type of head is much higher than others and of smaller diameter than the finished rivet head, many users believe that the initial pressure is applied at the center of the head, causing the upsetting of the rivet in the middle of the body and, consequently, its spreading so that it fills the hole tightly before the head is enlarged and driven to a tight bearing against the steel on the outside of the hole.

BIRTH OF THE AIR BRAKE

THE romantic story of George Westinghouse and the varied industrial enterprises that he founded or made possible has been told in an 80-page book published by the Westinghouse Electric & Manufacturing Company. Twenty men of importance in the nation, many of whom worked for or with Westinghouse and all of whom knew him, contributed to the writing of the saga.

Westinghouse's most outstanding services to society were in the field of electricity; but his greatest stroke for safety was his invention of the railroad air brake. Although in after years he was known among his employees and associates as "the old man," Westinghouse was in his early twenties when the idea of the air brake came to him. He got it through reading a magazine article about a compressed-air-operated rock drill. Here was the solution of the problem of eliminating hand braking on which he had been working for some time.

Soon he had an air brake ready for trial, and in April, 1869, he induced the Pennsylvania Railroad to test it. The train had barely got up speed when a huckster's wagon crossed the track in front of it. A startled and skeptical engineer applied the new brakes just in time to avert a disaster. As late as the 1880's, freight trains were limited to 30 cars in length and to maximum speeds of 15 miles an hour. The air brake made possible today's trains of 150 to 200 cars and speeds up to 50 miles an hour.

Industrial Notes

Some of the important quarries in the Quincy District of Massachusetts are said to be using a recently invented electromagnetic device for fishing broken bits out of drill holes.

We are told that an automobile, aside from tires, has more than 180 parts made of rubber. It is therefore not surprising that 80 per cent of the rubber goods produced in the United States is absorbed by that industry.

A telescope, a target, and an electric lamp are the principal features of an optical alignment tester designed by Carl Zeiss for the setting up of heavy machinery. It has a range of from 3½ to 120 feet, and is said to be accurate to within 0.0005 inch.

Ideal Commutator Dresser Company has introduced a cable ripper that is described as just the tool for use on nonmetallic, sheathed, duplex cable or on lead-covered cable. It is squeezed on to the cable and rips it clean with a single pull without damaging the wires.

Calicel is the name of a new material produced by The Celotex Corporation for soundproofing buildings. It is made of stone, which is reduced to a molten state by subjecting it to a temperature of more than 2,000°F. The product is highly porous, the raw material expanding anywhere from 10 to 40 times in volume.

Lime producers and farmers in our southern molasses belt will be interested in a new kind of stabilized-soil road that is finding favor in India. It is reported that a 4:2:1 mix of molasses, slaked lime, and charcoal powder will make a road surface that sets in four hours, that can be opened to traffic in 24 hours, and that is not affected by moderate rains.

Elevated highways in the congested districts of large cities long have been advocated by city planners; but it has remained for Holland to try out the scheme on a large scale. Rotterdam has 3 miles of these double-decker streets for the exclusive use of pedestrians, bicyclists, and push carts, and is proposing to build more. The upper level is two stories above the sidewalk and reached by stairs and elevators.

In view of the menace presented by the formation of ice on airplane wings, it is good news to learn that a simple method has been made available for its prevention. It was developed for the British Imperial Airways, according to information from the American Consulate General in London, and consists of painting the wings, propellers, and control surfaces of a flying machine with an anti-icing compound named Killfrost. The results obtained with it have been described as striking. The compound is also being used in refrigerating plants to keep the piping free from incrustation.

What is perhaps the largest single order for fencing ever placed has been awarded by the Metropolitan Water District of Southern California to the Anchor Post Fence Company. The contract calls for the delivery of 55 miles of 6-foot chain-link fence, which is to be placed around the reservoirs and along both sides of the open section of the Colorado River Aqueduct through which drinking water will be carried from Parker Dam to the City of Los Angeles and vicinity. The fence will be manufactured in the company's Baltimore and Los Angeles plants; will require the use of more than 1,500 tons of steel; and will cost $188,000, including transportation and erection.

It is no uncommon thing nowadays to use dry ice in assembling and dismantling shrunk fits. However, there are exceptional applications such as the one reported by the Queenstown hydroelectric station at Niagara Falls where repairs to a generator made it necessary to withdraw a 40-ton shaft from a 270-ton rotor. The shaft is approximately 30 feet long, 32 inches in diameter, and has an 8-inch bore, and was contracted by pumping through it a freezing mixture made up of 3 tons of dry ice and 350 gallons of alcohol. It was freed from its hold in about two hours, the mixture reaching a temperature of −97°F. With the repairs made, it was necessary to repeat the process to get the shaft back in place.

It has been suggested by no less a body than the British Aeronautical Research Committee that heat be tried to dispel fog obscuring landing fields from the view of airplane pilots. Increasing traffic, and the desire to maintain schedules with safety, has raised this question; and the committee, in a report published by it recently, has requested the installation of experimental heating plants at a number of British airports to determine whether or not the scheme is practicable—the plants to be large enough to keep a space 750 feet long, 100 feet wide, and 300 feet high clear of fog and mist for a period of five minutes. Though costly, such a service might be justified if effective.

Magnesium is the title of a 90-page bulletin that has been released recently by the Mining Experiment Station and Electrometallurgical Research Laboratories of the State College of Washington, Pullman, Wash. It was prepared by H. A. Doerner of the U. S. Bureau of Mines, and reports on the present outlook for a magnesium metal industry in the Northwest. It includes a discussion of the methods by which metallic magnesium may be obtained from magnesite ores, as well as descriptions of the various reduction processes, purification of the metal, processes for concentrating magnesite ores, etc. In addition, it contains a statistical review of the magnesium industry and a bibliography. Bulletin P, as it is designated, may be purchased from the State College of Washington for 35 cents.

The 1936 report of the Smithsonian Institution contains an account of the cryogenic laboratory at the University of Leiden, in Holland, which possesses outstanding facilities for producing low temperatures. Researches aimed at determining the behavior of various substances when extremely cold are continually carried on, and many world-famous scientists, including Madame Curie and Einstein, have conducted investigations there. Cold is produced by compressing and expanding various gases; and the equipment includes several high-pressure compressors. Liquid air is produced at the rate of 30 liters per hour, or 13,000 liters per year (13,737 quarts). Other gases that are regularly liquefied are hydrogen and helium. The latter liquefies at a temperature of −259°C. (−434°F.), which is obtained by compressing the gas to 1,500 pounds, cooling it with liquid hydrogen, and then further cooling it by expansion.

RETHREADING JACKRODS

In the blacksmith shop of a roadbuilding contractor, showing how the new Ingersoll-Rand Company thread-forging device for Jackrods is used in connection with the company's drill-steel sharpener. The device consists of a set of blocks and a die and, it is claimed, not only produces threads that are tougher and more resistant to drilling shock than those made in the usual way but also does the work in much less time. Approximately five hours ordinarily required for annealing machined threads are eliminated by this set-up which, according to the contractor's estimate, can rethread twenty rods in an hour.

New Hydraulic Cement

EXTRAORDINARY properties are being claimed for a new hydraulic cement that is being patented by R. S. Edwards, development engineer of the Rumford Chemical Company of Rhode Island. As described by Mr. Edwards before an American Society of Testing Materials Committee, the product is far superior to anything available in the field of gypsum cements, can be made at a cost of only $6.50 to $8 a ton—about the price range of ordinary portland cement, and can be manufactured from well-nigh any commercial grade of rock gypsum, anhydrite, or from synthetic (precipitated) gypsum which is a by-product of various chemical processes such as the wet process for the production of phosphoric acid, one of the essential ingredients of the new material.

Rumford Cement, as we shall call it to avoid confusion, is made as follows: Raw gypsum, ground so that it will pass through 80-mesh, is mixed with not more than 2 per cent of phosphoric acid and sodium phosphate, a silicate being added if the rock itself is not adequately siliceous. This material goes into a tumbling drum, where it is turned into pellets which are calcined at a temperature of from 1,800 to 2,300°F. in a tunnel kiln. The resultant clinker, which is as hard as marble and can be stored indefinitely without deteriorating, is ground just like portland-cement clinker. But instead of adding a retarder, the material is "catalyzed" with an accelerator, usually a mixture of potassium sulphate and zinc sulphate.

Whereas ordinary gypsum plasters and even portland cement have little strength, especially in the case of sanded mixtures, according to Paul M. Tyler of the U.S. Bureau of Mines, Rumford Cement is said to sustain 600 to 1,200 pounds per square inch in tension and to have ten times this strength in compression. The further claim is made that it resists the weather with less expansion and contraction than portland cement, the dissolving action of many acids, and mechanical wear.

So far Rumford hydraulic cement has been tested on a semicommercial scale for about two years, and was first used in the making of terrazzo floors in the laboratories of the plant where it was discovered. For the ordinary plastering of walls and ceilings the first coat can be controlled so as to set within one to two hours, the final one setting within four hours. In other words, two or even three coats can be applied in a day and the surfaces, because of the absence of free lime in the cement, painted in about the time it takes the first coat of an ordinary plastering job to become dry. As a substitute for portland cement, with the addition of similar proportions of sand and coarse aggregate, the new hydraulic cement will make for a stronger and more water repellent structure that can be put in service at least as soon as one built of special quick-setting portland cement.